EDGE OF SPACE:
EMERGING TECHNOLOGIES, THE 'NEW' SPACE INDUSTRY, AND THE CONTINUING DEBATE ON THE DELIMITATION OF OUTER SPACE

by

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ABSTRACT – ENGLISH

Nearly fifty years have passed since the beginning of the space age, but international lawmakers have yet to determine where airspace ends and outer space begins. This paper examines the need to settle the boundary dispute, specifically taking into account the effect it has on emerging technologies and the 'new' space industry.

The opening chapter examines the fundamental changes that have occurred since the beginning of the space age, both in terms of the technology and the space exploration infrastructure. The background of the delimitation question is then provided, followed by a discussion of the legal significance of the boundary issue. The final chapter analyzes the spatialist and functionalist approaches to the delimitation of outer space, looking at the pros and cons of each position.

ABSTRACT – FRENCH

Presque cinquante ans ont passé depuis le commencement de l'âge de l'espace, mais les législateurs internationaux n'ont plus déterminer où l'espace aérienfinit et l'espace extra-atmosphérique commence. Cet article examine la nécessité de régler le conflit de frontière, tenant compte spécifiquement de l'effet qu'il a sur des technologies naissantes et 'la nouvelle' industrie de l'espace extra-atmosphérique.

Le premier chapitre examine les changements fondamentaux qui se sont produits depuis le commencement de l'âge de l'espace, en termes de technologie et infrastructure d'exploration de l'espace. Le fond de la question de délimitation est alors fourni, suivi d'une discussion d'importance légale de l'issue de frontière. Le chapitre final analyse l'approche du spatialisme et celle du fonctionnalisme à la délimitation de l'espace extra-atmosphérique, en regardant le pour et le contre de chaque position.

ACRONYMS AND ABBREVIATIONS

ADIZ	Air Defense Identification Zone
AIAA	American Institute of Aeronautics and Astronautics
AST	Associate Administrator for Commercial Space Transportation (FAA)
CEV	Crew Exploration Vehicle
COPUOS	Committee on the Peaceful Uses of Outer Space (UN)
COTS	Commercial Orbital Transportation Services (NASA)
DARPA	Defense Advanced Research Projects Agency (U.S.)
ELV	Expendable Launch Vehicle
ESA	European Space Agency
FAA	Federal Aviation Administration
FAI	Fédération Aéronautique Internationale
FSA	Federal Space Agency of the Russian Federation
GEO	Geostationary Earth Orbit
HAPS	High Altitude Platform System
HTPB	Hydroxy-Terminated Polybutadiene (rubber)
JAXA	Japanese Aerospace Exploration Agency
ICAO	International Civil Aviation Organization
ICBM	Intercontinental Ballistic Missile
ICJ	International Court of Justice
IRBM	Intermediate Range Ballistic Missile
ISS	International Space Station
ITU	International Telecommunications Union
LEO	Low Earth Orbit
LOX	Liquid Oxygen
MDB	Myasishchev Design Bureau
MEO	Medium Earth Orbit
MRBM	Medium Range Ballistic Missile
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OSP	Orbital Space Plane
RLV	Reusable Launch Vehicle
SARPS	Standards and Recommended Practices (ICAO)
SLI	Space Launch Initiative
SSO	Single Stage to Orbit
UAV	Unmanned Aerial Vehicle

UNCD	United Nations Conference on Disarmament
UNOG	United Nations Offices at Geneva
UNOOSA	United Nations Office for Outer Space Affairs
USAF	United States Air Force
VTOL	Vertical Takeoff and Landing
WGDD	Working Group on the Definition and Delimitation of Outer Space (COPUOS)

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INTRODUCTION

The question of where airspace ends and outer space begins has been debated for nearly half a century, but today we are no closer to an answer than we were when the space age began. While the debate has continued, the world has changed. Space exploration, the industry that drives it, and the technology that enables it have all changed dramatically since the inception of the space age. As a result of these numerous and fundamental changes, resolving the boundary issue is becoming increasingly important.

This paper begins with a look at the fundamental changes that have occurred since the beginning of the space age, both in terms of technology and the space exploration infrastructure. Emerging technologies are discussed, along with the developments that are creating the 'new' space industry, particularly the growing commercial space segment and its involvement in areas such as space tourism and commercial spaceport development.

The second chapter examines the background of the delimitation dispute, looking at airspace from both the scientific and the legal perspective. The international legal regimes governing airspace and outer space are analyzed, particularly with respect to their underlying assumption that a boundary does exist, and impact they have on the resolution of the boundary issue. The chapter concludes with an overview of the history of the boundary debate and the identification of sources of a possible solution.

The third chapter addresses the legal significance of the boundary question. Legal issues related to the lack of a defined boundary are discussed, including the differences between air traffic and space traffic, issues of liability, issues that especially affect the emerging commercial space industry, and the need for uniform international regulation.

Finally, the last chapter contains an analysis of the spatialist and functionalist approaches. The pros and cons of both sides are examined, in an attempt to highlight why the sides have failed to come to an agreement over the last half century, and why each approach has international support and legal validity.

CHAPTER I.

NEW TECHNOLOGIES AND THE CHANGING FACE OF SPACE EXPLORATION

The space age began on 4 October 1957 when the U.S.S.R. launched Sputnik, the first artificial satellite, into orbit. In the nearly 50 years that have passed since that historic event, both space technology and the scope of space activities have changed dramatically. Space-related technologies have benefited from the numerous scientific and technological advancements that have taken place over the last half century. While powerful rockets derived from military technology still remain a staple launch vehicle, new technologies have the potential to revolutionize space access and change the way we think of space transportation.

Technology is not the only thing that changed over the first half-century of the space age. In 1957 the U.S. and the U.S.S.R. were in the midst of the Cold War, a state of affairs which persisted and dominated global politics until the early 1990s. The space age was born of, and grew up in, the Cold War environment and its politics consequently shaped space exploration. In the beginning only the U.S. and the U.S.S.R. had the ability to reach outer space; space-related research and development (and the resulting technologies) were heavily linked to military capabilities, meaning States effectively controlled access to space. While the U.S. and the U.S.S.R. were later joined by other States with space capabilities, those capabilities continued to remain in the hands of the various governments, with virtually no private or commercial presence in outer space.

Today things are changing, especially with respect to those technologies available for private and commercial space activities. Access to space and development of space transportation technologies are no longer exclusively in the hands of government; private citizens have visited outer space, commercial space ventures are being established, and commercial spaceports are under development. As demonstrated by the following discussion highlighting these new technologies and trends, after nearly 50 years the face of space exploration is set to change dramatically, a change being led and financed not by States, but by private enterprise, the 'new' space industry.

A. Emerging Space and Related Technologies

1. The Spaceplane/Reusable Launch Vehicles (RLVs)

Strictly speaking, there is nothing new about the RLV concept.[1] NASA's Space Shuttle, probably the most well-recognized example of RLV technology, has been operational since 1981.[2] While the Shuttle's rocket-powered vertical takeoff is unlike that of an aircraft, its gliding descent and runway landing depend on aerodynamics, effectively making the Shuttle function as an aircraft during the return portion of its flight.[3] However, apart from the Shuttle, unique among current space transportation technologies, RLVs are not presently employed as a means of space transportation.[4] NASA intends to retire the aging Shuttle fleet by 2010, replacing it not with a next generation RLV, but with the Crew Exploration Vehicle (CEV), based on the ELV (Expendable Launch Vehicle) technology used in the Apollo spacecraft.[5]

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1 See *e.g.* Richard L. Witkin, "Shuttle Meets Need for Reusable Craft that Could Also Serve Military's Ends" *New York Times* (10 April 1981) A18 (reporting on the history of the concept of RLVs, which goes back to the 1940s, and noting the significantly reduced costs associated with RLVs as opposed to the ELVs that preceded the Shuttle).

2 See *e.g.* John Noble Wilford, "Shuttle Rockets Into Orbit on First Flight; Some Tiles Fall Off, But NASA Sees No Danger" *New York Times* (13 April 1981) A1 (reporting on the 12 April 1981 inaugural launch of the Shuttle).

3 See *e.g.* Thomas O'Toole, "Space Shuttle Flight Will End Six Years of Earthbound U.S. Astronauts" *Washington Post* (5 April 1981) A2 (reporting on the preparations for the first Shuttle launch and noting that while it takes off "like a rocket" as prior spacecraft had done, "[u]nlike any spacecraft before it, Columbia will return to Earth and land on a runway like an airplane").

4 The U.S.S.R. developed the Buran, a RLV similar to the Shuttle, which made a successful, fully-automated (unmanned) flight, for the first and only time, on 15 November 1988. The Buran program was terminated due to lack of funding following the collapse of the U.S.S.R., and has not been used since its inaugural flight. See generally Felicity Barringer, "Soviet Space Shuttle Orbits and Returns in Unmanned Debut" *New York Times* (16 November 1988) A1 (reporting on the Buran's inaugural flight); "Gorbachev Hails First Soviet Shuttle Flight as a Coup" *Los Angeles Times* (15 November 1988) A2 (reporting the flight "broke the U.S. monopoly on reusable spacecraft"); Craig Covault, "Policy and Technology Shape Manned Space Ops" *Aviation Week & Space Technology* 154:2 (8 January 2001) 44 (discussing political reasons behind termination of Buran program); see also Craig Covault Bourget, "Buran Inspection Shows Soviet Shuttle Details" *Aviation Week & Space Technology* 130:25 (19 June 1989) 46 (reporting on technical details of the Buran).

5 See generally Eric Pianin, "Space Plan Envisions Apollo as Model; Versatile Craft is Key to Bush Program" *Washington Post* (10 January 2004) A1 (reporting on the plan to replace the Shuttle with the new CEV, "modeled on the 1960s vintage Apollo program," which would "supplant a proposal . . . to build an orbital space plane"); Peter Pae, "Back to Moon Via 'Apollo on Steroids'; NASA's $104-

a) Spaceplane Development in the Public Sector

NASA's decision to abandon the RLV Shuttle in favor of the ELV CEV does not signal the failure of the RLV concept, but rather is a reflection of the budgetary constraints faced by NASA, a federal agency with a budget dependent on federal funding.[6] Before turning to the CEV as the next step in space transportation, NASA had embarked on a number of programs that were supposed to yield the next generation RLV replacement for the Shuttle, such as various X-programs and the Orbital Space Plane (OSP) program.[7]

(1) X-33

The X-33 was envisioned as a single stage to orbit (SSO) RLV.[8] Like the Shuttle, the X-33 was to launch vertically like a traditional rocket, and land horizontally like an airplane.[9] The X-33 development contract was awarded to Lockheed Martin's Skunk Works on 2 July 1996, with an initial goal of having test flights take place by 1999.[10] The X-33 itself was to be a half-scale prototype of the eventual VentureStar, which was

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billion Plan to Revive Manned Lunar Missions is Seen as a Step Toward Mars Trip" *Los Angeles Times* (20 September 2005) A1 (discussing the plans to replace the Shuttle with the CEV and providing details about the CEV); Tarig Malik, "NASA's New Moon Plans: 'Apollo on Steroids'" *Space.com* (19 September 2005), online: Space.com <http://www.space.com/news/050919_nasa_moon.html> (discussing particulars of the planned CEV).

6 See generally Warren E. Leary, "Not So Fast, Lawmakers Say of NASA Plans for Space Plane" *New York Times* (28 October 2003) A22 (reporting the House Science Committee "asked NASA to postpone plans" for developing an orbital space plane); Kathy Sawyer, "Lawmakers Want NASA to Postpone New Space Plane" *Washington Post* (28 October 2003) A5 (reporting that "[c]iting policy and budget concerns, key members of Congress have called on NASA Administrator Sean O'Keefe to postpone further work on the next U.S. space plane designed to carry crews to and from orbit").

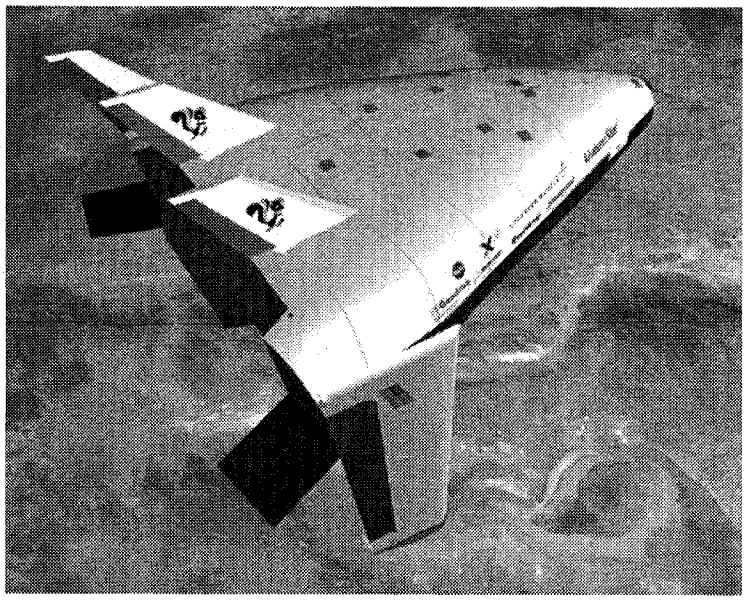
7 See *e.g.* Frank Sietzen, Jr. & Keith L. Cowing, *New Moon Rising: The Making of America's New Space Vision and the Remaking of NASA* (Burlington, Ontario: Apogee, 2004) at 123 (describing these programs as "false starts" in discussing the history leading up to the plans for the new CEV); Kim Cobb, "The Return to Flight; As NASA Evolves, What Will Replace the Shuttle?" *Houston Chronicle* (5 July 2005) A1 (reporting that NASA "[p]lans for the X-33, X-34, X-37, X-38 and Orbital Space Plane were all abandoned, some because of congressional reluctance to provide funding").

8 NASA, "X-33 Advanced Technology Demonstrator Historical Fact Sheet" *NASA Marshall Space Flight Center Fact Sheets*, online: NASA <http://www.nasa.gov/centers/marshall/news/background/facts/x33.html>.

9 *Ibid.*

10 *Ibid.*

seen as a replacement vehicle for the Shuttle.[11] The X-33 program suffered through several delays and accidents, which led to its eventual cancellation in March 2001, prior to reaching the test flight stage.[12]



X-33 Concept[13]

(2) X-34

Orbital Sciences Corporation was awarded the X-34 development contract in August 1996.[14] The X-34, powered by a single stage engine, was designed as a test vehicle for various RLV technologies.[15] The X-34 was to be air-launched (horizontally)

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11 *Ibid.*

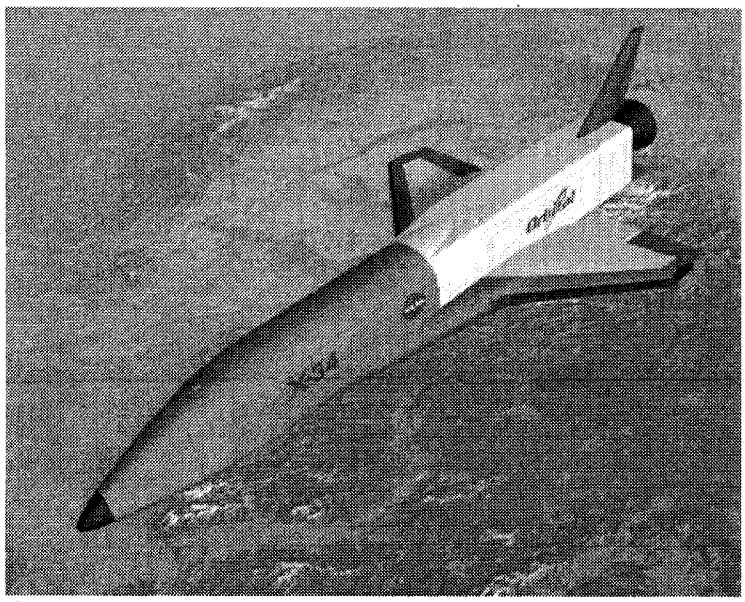
12 See *e.g.* Sietzen & Cowing, *supra* note 7 at 124-26; Leonard David, "NASA Shuts Down X-33, X-34 Programs" *Space.com* (1 March 2001), online: Space.com <http://www.space.com/missionlaunches/missions/x33_cancel_010301.html> ["NASA Shuts Down X-33, X-34 Programs"].

13 NASA, "Artist's Concept of X-33 Advanced Technology Demonstrator" *Marshall Space Flight Center*, online: NASA <http://www.nasa.gov/centers/marshall/images/content/99850main_x33_10_14_98_m.jpg>.

14 NASA, X-34: Demonstrating Reusable Launch Vehicle Technologies Historical Fact Sheet" *NASA Marshall Space Flight Center Fact Sheets*, online: NASA <http://www.nasa.gov/centers/marshall/news/background/facts/x-34.html>.

15 *Ibid.*

from a carrier aircraft and have the ability to land on a runway, like a conventional aircraft.[16] The X-34 program was cut by NASA, along with the X-33, program in 2001.[17]



X-34 Concept[18]

(3) X-37

Like the cancelled X-34 program, the X-37 was designed to test launch other spaceflight technologies.[19] Boeing's Phantom Works began work on the X-37 program in July 1999, with plans to develop two separate X-37 vehicles – the Approach and Landing Test Vehicle and the Orbital Test Vehicle.[20] Also similar to the X-34, the X-37 design calls for an air-launch and a runway landing.[21] Due to budget considerations,

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16 *Ibid.*

17 See *e.g.* "NASA Shuts Down X-33, X-34 Programs," *supra* note 12.

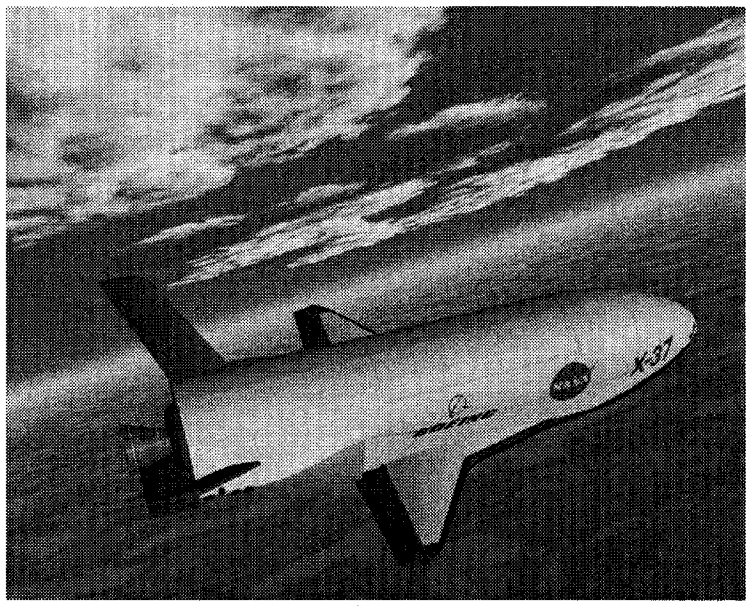
18 NASA, "Artist's Concept of X-34 Technology Demonstrator" *Marshall Space Flight Center*, online: NASA <http://www.nasa.gov/centers/marshall/images/content/100352main_x34render_m.jpg>.

19 NASA, "X-37 Demonstrator to Test Future Launch Technologies in Orbit and Reentry Environments" *NASA Marshall Space Flight Center Fact Sheets*, online: NASA <http://www.nasa.gov/centers/marshall/news/background/facts/x37facts2.html>.

20 *Ibid.*

21 *Ibid.*

NASA asked Boeing to scale back its work on the X-37 program in late 2003,[22] and in September 2004 the program was taken over by the U.S. Defense Advanced Research Projects Agency (DARPA).[23] Under DARPA's control, the X-37 program remains active; a drop test was conducted from Scaled Composites' White Knight carrier aircraft on 7 April 2006.[24]



X-37 Concept[25]

(4) X-38

While not intended as a total replacement vehicle for the Shuttle, the X-38 Crew Return Vehicle was supposed to fill a gap left by the eventual retirement of the Shuttle

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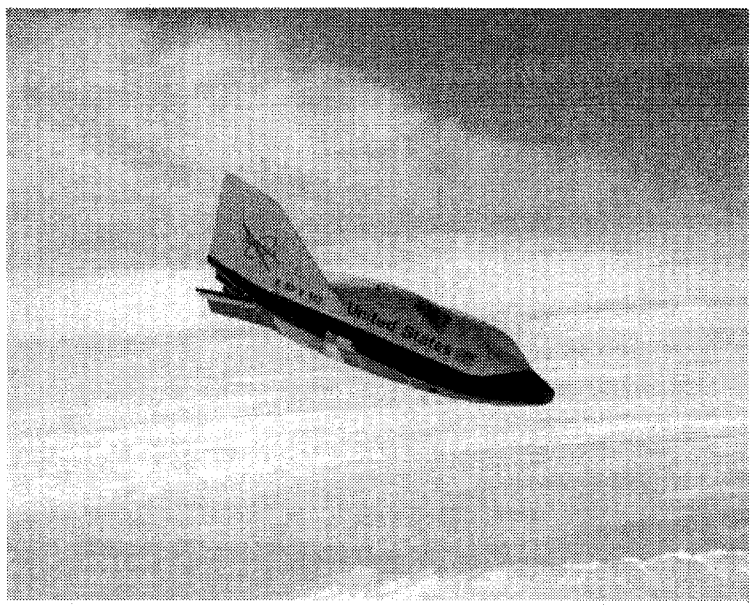
22 See *e.g.* Frank Morring, Jr., "'Deemphasize' X-37 Orbital Vehicle, Boeing Told, as NASA Encounters Cost, Technology Turbulence" *Aviation Week & Space Technology* 159:24 (15 December 2003) 22.

23 See *e.g.* Graham Warwick, "DARPA takes over control of X-37; NASA Decides Programme Does Not Support its Goals, Although it Will Remain Involved as Technical Consultant" *Flight International* (21 September 2004) at 28.

24 See *e.g.* Jim Skeen "Experimental Aircraft Damaged in Test Flight" The Daily News of Los Angeles (8 April 2006) AV1; Norris "DARPA Reviews Flaws in 'Flawless' X-37 Drop Test" *Flight International* (18 April 2006) 1.

25 NASA, "Artist's Concept of X-37 Flying Through the Clouds" *Marshall Space Flight Center*, online: NASA <http://www.nasa.gov/centers/marshall/images/content/100358main_X-37_in-clouds_m.JPG>.

fleet – the ability to evacuate crew from the International Space Station (ISS).[26] The X-38 was to have been delivered to the ISS by the Shuttle, attached to an ISS docking port, and able to be undocked in the event an emergency evacuation was required.[27] The X-38 then "would return to Earth much like a space shuttle."[28] Despite seven years of work, and reaching the point where preparations were being made for a final test flight, the X-38 was cancelled for political and budgetary reasons in April 2002, when the $1.3 billon project was on the verge of success.[29]



X-38 Prototype[30]

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26 NASA, "X-38 Fact Sheet" *NASA Dryden Flight Research Center Fact Sheets*, online: NASA <http://www.nasa.gov/centers/dryden/news/FactSheets/FS-038-DFRC.html>.

27 *Ibid.*

28 *Ibid.*

29 See *e.g.* Tony Freemantle & Mike Tolson, "Beyond Columbia; X-38 Death Crushed Many NASA Dreams" *Houston Chronicle* (23 July 2003) A1 (reporting the X-38's "fate was similar to some of its X-brethren in the 1980s and '90s that were undertaken by NASA to satisfy a perceived need and then abandoned because of shifting priorities, cost overruns, technical barriers or a combination thereof. Despite billions of dollars in developments costs, not one vehicle has been produced").

30 NASA, "X-38 Ship #2 in Free Flight" *NASA Dryden Flight Research Center Photo Collection*, online: NASA <http://www.dfrc.nasa.gov/Gallery/Photo/X-38/Small/EC99-45080-21.jpg>.

(5) X-43

The X-43 is part of NASA's Hyper-X program, the goal of which is air-breathing hypersonic flight.[31] The X-43A, employing scramjet[32] technology which is envisioned to be a possible component of future spaceflight technologies,[33] underwent a third successful test flight in November 2004, reaching a record-breaking speed of Mach 10.[34] That test, however, marked the end of the funding for NASA's hypersonic programs,[35] as the X-43B and X-43C programs were cancelled.[36] Although NASA no longer has an

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31 NASA, "NASA 'Hyper-X' Program Demonstrates Scramjet Technologies; X-43A Flight Makes Aviation History" *NASA Dryden Flight Research Center Fact Sheets*, online: NASA <http://www.nasa.gov/centers/dryden/news/FactSheets/FS-040-DFRC.html> [NASA, "X-43 Flight Makes History"].

32 A scramjet is a supersonic combustion ramjet. NASA offers the following descriptions of ramjets and scramjets:

> A ramjet operates by subsonic combustion of fuel in a stream of air compressed by the forward speed of the aircraft itself, as opposed to a normal jet engine, in which the compressor section (the fan blades) compresses the air. Ramjets operate from about Mach 3 to Mach 6.
>
> A scramjet (supersonic-combustion ramjet) is a ramjet engine in which the airflow through the whole engine remains supersonic. It is thought that a scramjet can operate from Mach 5-6 up to at least Mach 15.

Ibid.

The first successful flight demonstration of scramjet technology was conducted on 16 August 2002 by University of Queensland (Australia) researchers at Woomera, as part of Australia's HyShot program for in-flight validation of scramjet technology. See Leonard David, "Results Just In: HyShot Scramjet Test a Success" *Space.com* (16 August 2002), online: Space.com <http://www.space.com/missionlaunches/hyshot_020816.html>.

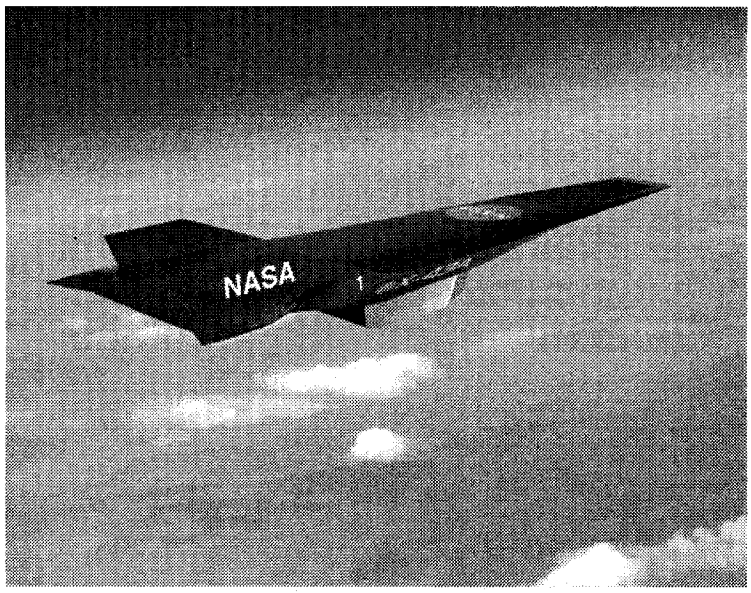
33 See FAA/AST, "2006 Commercial Space Transportation Developments and Concepts: Vehicles, Technologies and Spaceports" (January 2006) at 38, online: FAA/AST <http://ast.faa.gov/files/pdf/newtech2006.pdf> [FAA/AST, "2006 Commercial Space Developments"] (stating that "[h]ypersonic vehicles promise to enable future RLV systems, such as two-stage-to-orbit systems").

34 See *e.g.* NASA, "X-43 Flight Makes History," *supra* note 31; Jason Bates, "Senators Add Funding for More NASA Hypersonic Work" *Space.com* (29 November 2004), online: Space.com <http://www.space.com/spacenews/archive04/hypersonicarch_112204.html>.

35 See *e.g.* Frank Morring, Jr. & Michael A. Dornheim, "Last Mile; X-43A Team Claims $500-Million Air-Breathing First Stage Could Handle 80% Of Payloads" *Aviation Week & Space Technology* 161:17 (1 November 2004) 56.

36 See *e.g.* Michael A. Dornheim, "A Breath of Fast Air" *Aviation Week & Space Technology* 160:14 (5 April 2004) 28 (reporting "an envisioned hydrocarbon-fueled X-43C version was recently cancelled by the agency's [NASA's] new Exploration Initiative and the X-43B died stillborn"); Michael A. Dornheim, "Mach 10, But Now What? Tests to Continue with Military, But NASA's Role Becomes

active hypersonic aircraft research program, DARPA and the U.S. Air Force are currently working on the X-51 hypersonic vehicle, which is based on work done for the X-43 program.[37]



X-43A Concept[38]

(6) The OSP

The OSP was one of two programs in development under NASA's Space Launch Initiative (SLI), established in February 2001.[39] The developmental goals for the OSP were to design a craft capable of serving as a rescue vehicle for ISS crew, which could later be expanded into a vehicle capable of carrying crew and cargo to the ISS, and

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Unclear" *Aviation Week & Space Technology* 161:20 (22 November 2004) 24 (discussing the successful Mach 10 test flight and the future of hypersonics research).

37 See generally Ann Finkbeiner, "Hypersonics Redux" *Aviation Week & Space Technology* 164:5 (30 January 2006) 51 (describing current hypersonic programs).

38 NASA, "X-43A Hypersonic Experimental Vehicle – Artist Concept in Flight" *NASA Dryden Flight Research Center Photo Collection*, online: NASA <http://www.dfrc.nasa.gov/Gallery/Photo/X-43A/Small/ED99-45243-01.jpg>.

39 NASA, "Beginning a New Era of Space Flight: The Orbital Space Plane" *NASA Marshall Space Flight Center Fact Sheets*, online: NASA <http://www.nasa.gov/centers/marshall/news/background/facts/ospfacts.html>. The two programs under the SLI were the OSP and Next Generation Launch Technology programs. *Ibid.*

perhaps ultimately become the basis for a routine space crew transfer vehicle.[40] Despite the inclusion of the word 'plane' in the OSP label, the design for the OSP was never finalized and of the concepts being considered, not all of them would have actually fit the label 'spaceplane.'[41] In late 2003 Congress asked NASA to put the OSP program on hold.[42] Following the 14 January 2004 announcement of the "New Vision for Space Exploration"[43] the OSP program was cut in favor of the CEV program, marking the end (at least for the present) of NASA's attempt to replace the Shuttle with another spaceplane type of RLV.[44]

b) Spaceplane Development in the Private Sector

While NASA may be looking back at Apollo for its upcoming CEV, and a spaceplane replacement for the Shuttle is not in the immediate future, RLV development

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40 *Ibid.* Initially the X-37 was to be used to test technology being considered for inclusion in the OSP. *Ibid.*

41 See generally Leonard David, "The Next Shuttle: Capsule or Spaceplane?" *Space.com* (21 May 2003), online: Space.com, <http://www.space.com/businesstechnology/technology/osp_debate_030521.html> (discussing the debate with respect to the OSP design).

42 See generally Jason Bates, "House Committee Urges NASA to Halt Work on Orbital Space Plane" *Space.com* (27 October 2003), online: Space.com <http://www.space.com/news/osp_congress_031027.html> (reporting "[t]he leadership of the House Science Committee, the Congressional panel that authorizes NASA programs, wants NASA to halt work on the Orbital Space Plane, because of budget issues and concerns over the direction of the agency[']s human space flight program").

43 U.S. The White House, "President Bush Announces New Vision for Space Exploration Program" *White House Office of the Press Secretary* (14 January 2004), online: White House <http://www.whitehouse.gov/news/releases/2004/01/20040114-1.html> (providing the complete text of the President's speech announcing the new direction for the U.S. space program). See also Sietzen, Jr., *supra* note 7 at 160-67 (describing President Bush's speech and related events on 14 January 2004).

44 See generally Frank Morring, Jr., "Charting a Course" *Aviation Week & Space Technology* 160:4 (26 January 2004) 22; Brian Berger, "NASA Takes Small Steps While Awaiting Space Plan Approval" *Space.com* (25 May 2004), online: Space.com <http://www.space.com/spacenews/archive04/nasaarch_052504.html> (reporting NASA "shut down the Orbital Space Plane program and other launch technology efforts in order to clear the decks for a more versatile Crew Exploration Vehicle capable of transporting astronauts to the moon"); Seitzen, Jr., *supra* note 7 at 139-46 (chronicling the demise of the OSP program).

is continuing in the private sector.[45] Several private companies, such as Scaled Composites, Rocketplane, and XCOR, are presently working to develop new RLVs.[46] Private development and commercial application of RLV technology marks a significant turn in the use of and access to outer space. Until recently such use and access, especially in the realm of human space activities, has been under the exclusive control of government, with the U.S. government, through the Shuttle program, having sole control over the only in-use, functional spaceplane since the technology debuted in 1981.

(1) SpaceShipOne/SpaceShipTwo

On 4 October 2004 SpaceShipOne won the $10 million Ansari X-Prize, climbing to a height of 112 km.[47] Designed by Burt Rutan and constructed by his company, Scaled Composites, SpaceShipOne became the first privately-built and financed spacecraft to reach outer space.[48] SpaceShipOne takes off and lands like a conventional aircraft, though at takeoff it is attached to its carrier aircraft, White Knight.[49] The SpaceShipOne design incorporates hybrid rocket engines, utilizing N_2O as an oxidizer and HTPB

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45 See generally John S. Edwards, "RLV Challenges; Space Tourism Driving Suborbital Vehicles, But Big Obstacles Remain" *Aviation Week & Space Technology* 164:3 (16 January 2006) 150 (discussing development of commercial RLVs) [Edwards, "RLV Challenges"]; Tim McElyea, *A Vision of Future Space Transportation: A Visual Guide to Future Spacecraft Concepts* (Burlington, Ontario: Apogee, 2003) at 146-48 (briefly describing private spaceflight initiatives); "Space Travel Price No Longer Out of This World; Private Firms are Developing Rocket Planes for Commercial Flights in 2007 or 2008" *Los Angeles Times* (24 March 2006) C7 ["Space Travel Price No Longer Out of This World"] (reporting on development of commercial space transportation).

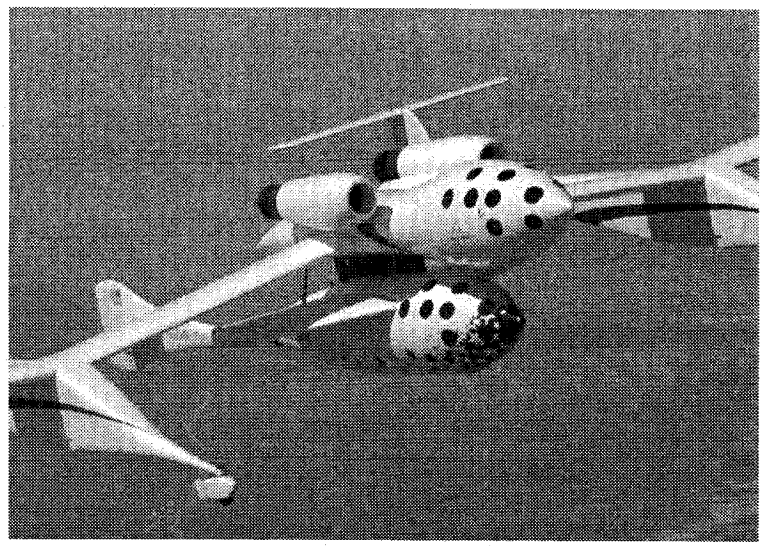
46 See generally John Edwards, "New Dawn for RLVs; In Addition to SpaceShipOne, Other Private Ventures Are Pursuing Reusable Launchers Despite Tight Funding" *Aviation Week & Space Technology* 162:3 (17 January 2005) 137 (reporting on private companies involved in RLV development).

47 See *e.g.* Scaled Composites, LLC, "SpaceShipOne Captures X-Prize," online: Scaled Composites, LLC <http://www.scaled.com/projects/tierone/041004_spaceshipone_x-prize_flight_2.html> (describing the prize-winning flight and providing links to other accounts); Michael A. Dornheim, "SpaceShipWon; FAA Administrator Hints Spaceships May Be Treated Like Experimental Aircraft" *Aviation Week & Space Technology* 161:14 (11 October 2004) 34 ["SpaceShipWon"] (describing the X-Prize winning flight of SpaceShipOne)

48 Dornheim, "SpaceShipWon," *supra* note 47.

49 *Ibid.* See also *supra* note 24 and accompanying text (regarding the use of White Knight to conduct drop tests of the air-launched X-37).

(rubber) as the fuel.[50] Once it reaches a suitable altitude, SpaceShipOne separates from White Knight and the rocket engines are ignited for the trip to outer space.[51] Following atmospheric reentry, SpaceShipOne glides to a landing.[52] The successful flight of SpaceShipOne, now on display in the Smithsonian Air & Space museum, demonstrated the ability of private entities to enter space on their own, and shows that commercial development of space transportation vehicles has become a reality.



White Knight and SpaceShipOne[53]

Following the successful flight of SpaceShipOne, the rights to the technology were purchased by Virgin Galactic[54] and in the summer of 2005 a joint venture between

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50 See especially Scaled Composites, LLC, "Tier One Private Manned Space Program: Frequently Asked Questions: Propulsion," online: Scaled Composites, LLC <http://www.scaled.com/projects/tierone/faq.htm> (describing the propulsion system).

51 Dornheim, "SpaceShipWon," *supra* note 47.

52 *Ibid.*

53 NASA, "SpaceShipOne" *Astronomy Photo of the Day* (27 June 2003), online: NASA <http://apod.gsfc.nasa.gov/apod/ap030627.html>.

54 See *e.g.* Michael A. Dornheim, "Sir Space Tourist; Virgin Galactic Eyes Follow-on Generation Going to Orbit and Around the Moon" *Aviation Week & Space Technology* 161:13 (4 October 2004) 30; "Virgin Galactic Plans to Build" *Aviation Week & Space Technology* 163:24 (19 December 2005) 11 ["Virgin Galactic Plans to Build"].

Scaled Composites and Virgin Galactic was announced.[55] This joint venture, known as The Spaceship Company, will work off of the SpaceShipOne platform to develop a new spacecraft, referred to as SpaceShipTwo, and will ultimately build a fleet of the spaceships for Virgin Galactic.[56] SpaceShipTwo will take-off and land in the same manner as SpaceShipOne, but will be twice the size.[57] Development of SpaceShipTwo is expected to be complete by 2008, the year Virgin Galactic's commercial space flights are scheduled to begin.[58]

(2) Dream Chaser

Under development by SpaceDev, Inc., the Dream Chaser RLV was originally slated to be based on the X-34 concept, but that was abandoned in favor of the current concept which is based on the HL-20 system developed by NASA-Langley.[59] Based on the current design, the Dream Chaser will be capable of carrying six passengers.[60] SpaceDev plans to introduce both suborbital and orbital versions of the Dream Chaser, with the suborbital version using "internal hybrid rocket motors" to power its vertical takeoff and the orbital version launching vertically "on the side of three large hybrid

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55 See *e.g.* Scaled Composites, LLC, "Branson and Rutan Form 'The Spaceship Company' To Jointly Manufacture and Market Spaceships for the new Sub-Orbital Personal Spaceflight Industry," online: Scaled Composites, LLC <http://www.scaled.com/news/2005-07-27_branson_rutan_spaceship_company.htm>; Frances Fiorino, "The Sky's No Limit; A Few Aviation Innovators Are Ready to Beam the Public Up to the Final Frontier" *Aviation Week & Space Technology* 163:5 (1 August 2005) 34.

56 See *e.g. ibid.*

57 See *e.g. ibid.*

58 See *e.g. ibid* (reporting Virgin Galactic "expect[s] to fly about five sponsors in about three years"); Graeme Kennedy, "Branson Plans Tourists in Space By 2008; US Government Sets Up Rules for Space Venturers" *National Business Review [New Zealand]* (27 January 2006) 25 (reporting Virgin Galactic "plans to send its first tourists into space from the Mojave Desert as early as 2008").

59 See SpaceDev, Inc., "SpaceDev's Dream Chaser" *Missions*, online: SpaceDev, Inc. <http://www.spacedev.com/newsite/templates/subpage2_article.php?pid=542> (detailing the Dream Chaser Concept); Tarig Malik, "Private Spacecraft Developer Settles on New Design" *Space.com* (23 November 2005), online: Space.com <http://www.space.com/missionlaunches/051123_spacedev_dreamchaser.html> (noting that SpaceDev decided not to base the Dream Chaser on the X-34 design concept).

60 SpaceDev, Inc., *supra* note 59.

boosters."[61] Both versions of the craft will make horizontal runway landings.[62] Currently the Dream Chaser, which was recently chosen as a finalist for NASA's COTS competition,[63] is expected to undergo manned suborbital test flights by 2008 and manned orbital test flights by 2010.[64]

(3) Explorer

The Explorer spacecraft is manufactured by Russia's MDB, under the supervision of the FSA, and funded by a joint venture between Space Adventures, Ltd. and the investment firm Prodea.[65] The Explorer, a five-seat suborbital spaceplane based on the C-21 RLV concept (also designed by MDB), will be air-launched from the currently operational M-55X carrier aircraft.[66] Further design details on the Explorer have not been released.[67]

(4) New Shepard

Blue Origin has disclosed almost no technical or design information on its New Shepard spacecraft,[68] which represents a different type of RLV in that it is being designed

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61 *Ibid.* The internal hybrid rockets will be "a scaled-up version of SpaceDev's non-explosive, rubber-burning hybrid rocket motors," which were used by SpaceShipOne during its X-Prize flights. *Ibid.*

62 *Ibid.*

63 Tarig Malik, "Competition Heats Up for NASA's Space Cargo Contract" *Space.com* (31 May 2006), online: Space.com <http://www.space.com/businesstechnology/060531_techwed_cots.html>.

64 SpaceDev, Inc., *supra* note 59.

65 See especially Space Adventures, Ltd., "Space Tourism Pioneers, Space Adventures, and the Ansari X-Prize Title Sponsors, to Provide First Suborbital Spaceflight Tourism Vehicles" *Space Adventures Press Releases* (16 February 2006), online: Space Adventures, Ltd. <http://www.spaceadventures.com/media/releases/2006-02/346> ["Space Tourism Pioneers"] (announcing "a contract with Prodea, a private investment firm founded by the Ansari family, and a separate contract with the Federal Space Agency of the Russian Federation (FSA), to develop a fleet of suborbital spaceflight vehicles for commercial use globally").

66 See *e.g.* Tarig Malik, "Suborbital Rocketship Fleet to Carry Tourists Spaceward in Style" *Space.com* (22 February 2006), online: Space.com <http://www.space.com/businesstechnology/060222_techwed_spaceadventures.html>.

67 *Ibid.*

68 There is currently virtually no technical information on the Blue Origin website. See Blue Origin, LLC, "Blue Origin," online: Blue Origin, LLC <http://www.blueorigin.com/>.

as a VTOL craft.[69] The rocket portion will reportedly consist to two parts, a propulsion module and a crew capsule capable of carrying three passengers, and will be powered by hydrogen peroxide and kerosene.[70] A recent environmental assessment turned in to the FAA/AST[71] has provided some additional details about the possible capabilities of New Shepard, which include proposed launch altitudes of over 99 km (325,000 ft).[72] The environmental assessment also reveals that New Shepard will be composed of a crew capsule which sits atop a propulsion module, with both components being reusable.[73] Prototype testing could begin as early as late 2006 and commercial operations are not expected to begin until after 2010.[74]

(5) Rocketplane XP

The Rocketplane XP is a RLV being developed by Oklahoma-based Rocketplane Limited.[75] The XP spaceplane is essentially a Learjet 25, which is heavily modified for spaceflight.[76] The modifications include a delta wing, changed tail section (to a V-tail), a thermal protection system (TPS), and the installation of a rocket engine utilizing a

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69 See *e.g.* "Rocket Renaissance: The Era of Private Spaceflight is About to Dawn" *Economist* (13 May 2006) (Lexis) (noting that although designers claim the New Shepard is a suborbital craft, the VTOL design could make for an easier transition to an orbital craft and also is a prerequisite to NASA's Lunar Lander Challenge).

70 Leonard David, "Bezos' Blue Origin to Set Up Rocket HQ in Washington State" *Space.com* (9 November 2005), online: Space.com <http://www.space.com/news/051109_blueorigin.html> (reporting based on information in a "briefly-posted document on the Blue Origin web site").

71 A PDF copy of the draft environmental assessment is available online from the FAA/AST at: http://ast.faa.gov/pdf/20060622_Draft_EA_As_Published.pdf.

72 See *e.g.* Leonard David, "Tourism Update: Jeff Bezos' Spaceship Plans Revealed" *Space.com* (5 July 2006), online: Space.com <http://www.space.com/businesstechnology/060705_blue_origin.html>.

73 See *supra* note 71.

74 *Ibid.*

75 See *e.g.* Rocketplane Limited, Inc. "About Rocketplane," online: Rocketplane Ltd., Inc. <http://www.rocketplane.com/en/company/default.asp> (providing background information on Rocketplane, Ltd.); Molly McMillin, "Tickets to Space" *Wichita [Kansas] Eagle* (16 April 2006) (noting that Rocketplane Ltd. purchased Kistler Aerospace Corp., which was "developing the K-1 reusable aerospace vehicle, designed to deliver payloads to orbit or serve the International Space Station," in March 2006 and the combined company will be called Rocketplane-Kistler).

76 See especially Harikishin P. Bakhtiani et al., "Rocketplane XP – Conceptual Design Study" (Paper presented at the 44th AIAA Aerospace Sciences Meeting, 9-12 Jan. 2006) [AIAA 2006-1239], online: Rocketplane Ltd., Inc. <http://www.rocketplane.com/media/pdfextras/AIAA-2006-1239.pdf> (providing a detailed description of the XP characteristics and capabilities).

LOX/kerosene propellant, which will take over from the two jet engines at altitudes between 18,000-30,000 feet (approximately 5.5-9.1 km) for the final push into space.[77] The XP will takeoff and land horizontally on runways, like a traditional aircraft.[78] The initial XP model will have a top speed of Mach 3.5 and the ability to reach altitudes of more than 100 km.[79] The XP is "due to enter service in late 2007."[80]

(6) Xerus

Xerus is the RLV under development by XCOR Aerospace.[81] Although Xerus is still in the design phase, XCOR has already partnered with Space Adventures, which will use the Xerus for it suborbital space tourism business.[82] Like the Rocketplane XP, Xerus will reportedly incorporate a delta wing[83] and launch and land horizontally on a runway, like a conventional aircraft.[84] Xerus' rocket engine, designed in-house by XCOR and

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77 See especially *ibid*; Rocketplane Limited, Inc. "Model XP Specifications," online: Rocketplane Ltd., Inc. <http://www.rocketplane.com/en/technical/xp-specs.asp> (describing the XP specifications) ["Model XP Specifications"]. The TPS utilizes titanium leading edges and ceramic paint, with ceramic blankets in certain high-heat areas. See Rocketplane Limited, Inc. "Model XP Sub-System," online: Rocketplance Ltd., Inc. <http://www.rocketplane.com/en/technical/xp-systems.asp>.

78 See especially "Model XP Specifications," *supra* note 77; Bakhtiani et al., *supra* note 76.

79 See especially "Model XP Specifications," *supra* note 77; Bakhtiani et al., *supra* note 76.

80 Bakhtiani et al., *supra* note 76.

81 See *e.g. ibid.*; Frank Morring, Jr., "Licensed to Fly" *Aviation Week & Space Technology* 160:18 (3 May 2004) at 19 (reporting XCOR "received FAA's second reusable launch vehicle (RLV) license . . . [covering] launches directly from the ground, which will allow it to fly its planned Xerus spaceplane") [Morring, Jr., "Licensed to Fly"].

82 See XCOR Aerospace, "Going Suborbital," online: XCOR Aerospace <http://www.xcor.com/suborbital.html> (noting "XCOR has a contract in place with Space Adventures to provide this [suborbital] experience to adventure travelers for $98,000") ["Going Suborbital"]; Edwards, "RLV Challenges," *supra* note 45.

83 See "Going Suborbital," *supra* note 82 (showing possible designs of Xerus including a delta wing) ; Edwards, "RLV Challenges," *supra* note 45 (commenting on Space Adventures' anticipation of "XCOR Aerospace's rollout of the delta-winged Xerus vehicle").

84 See *e.g.* "Going Suborbital," *supra* note 82 (stating "[t]he Xerus takes off and lands from a conventional runway, like an airplane"); Morring, Jr., "Licensed to Fly," *supra* note 81 (noting XCOR's FAA license will allow Xerus to be launched "directly from the ground").

based on its existing rocket engine line, will utilize a LOX/Kerosene propellant.[85] Xerus will be able to surpass the 100 km mark and reach speeds of about Mach 4.[86]

c) International RLV Development Efforts

RLV development is not, of course, limited to the U.S. public and private sectors. In the late 1980s the U.S.S.R. completed development of the Buran, a RLV similar to NASA's Shuttle.[87] Although the inaugural flight of the Buran was also its final flight, the termination of the program was due to the political turmoil and economic difficulties faced by the U.S.S.R. at that time; the technology itself was successfully proven operational.[88] Aside from the Buran and the Shuttle, no other RLV has been successfully developed and employed by a national space agency. However, several agencies have considered, or are considering, development of RLV technology.

In Russia the FSA has been working in conjunction with the RSC Energia Corporation on development of the Clipper (Kliper), a RLV seen as an alternative to NASA's CEV.[89] The Clipper, a winged spacecraft launched by a Soyuz rocket, will be capable of carrying six crewmembers.[90] Although launched by rockets, like the Shuttle the Clipper will be capable of making a gliding descent through the atmosphere and landing on a runway like a conventional aircraft.[91] ESA and JAXA have expressed interest in participating in Russia's spacecraft development program, though not

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85 See especially "Going Suborbital," *supra* note 82 (discussing the propellant system to be used on Xerus).

86 *Ibid.*

87 See *supra* note 4 (discussing the Buran).

88 *Ibid.*

89 See *e.g.* Tarig Malik, "Russia's Next Spaceship: Alternative to NASA's CEV" *Space.com* (7 December 2005), online: Space.com <http://www.space.com/businesstechnology/051207_tech_wednesday.html> (discussing the Clipper development efforts).

90 *Ibid.*

91 See RSC Energia, "RSC Energia: Concept of Russian Manned Space Navigation Development" *RSC Energia News* (24 May 2006), online: RSC Energia <http://www.energia.ru/english/energia/news/news-2006/public_07-01.html> (providing technical details regarding the Clipper program).

specifically in the development of the Clipper, thus establishing international cooperation toward the development of a future spacecraft.[92] JAXA is also considering developing its own spaceplane,[93] and to that end has already conducted tests using the HOPE-X in working toward its spaceplane development goal.[94] Meanwhile ESA, which scrapped plans to develop the Hermes spaceplane in the early 1990s,[95] has stated that it has no plans to independently develop a manned spacecraft.[96]

2. *High Altitude Platforms/Stratospheric Platforms*

A high altitude or stratospheric platform (HAPS) is exactly what the term suggests – a platform operating from a high altitude above the Earth.[97] The HAPS will

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92 See generally Peter B. de Selding, "ESA, Russia to Collaborate on New Spacecraft Design" *Space.com* (23 June 2006), online: Space.com <http://www.space.com/news/060623_clipper_esa.html> ["ESA, Russia to Collaborate] (reporting that the "European Space Agency (ESA) governments agreed June 22 to participate in a two-year program with Russia, and probably Japan as well, to explore crew-transport vehicle designs for missions to the international space station, the Moon and elsewhere"); Michael A. Taverna, "Global Spaceships; Europeans Seek Role on Russian Clipper, U.S. Crew Exploration Vehicle" *Aviation Week & Space Technology* 165:4 (24 July 2006) 72.

93 JAXA, "Next Generation Space Vehicle" *Projects: Space and Aeronautic Engineering Research*, online: JAXA <http://www.jaxa.jp/missions/projects/engineering/space/next/index_e.html> (stating that "new systems being considered by JAXA include fully reusable spaceplanes, which have wings similar to those of airplanes and can take off in a horizontal position from a runway, shuttling between the Earth and space").

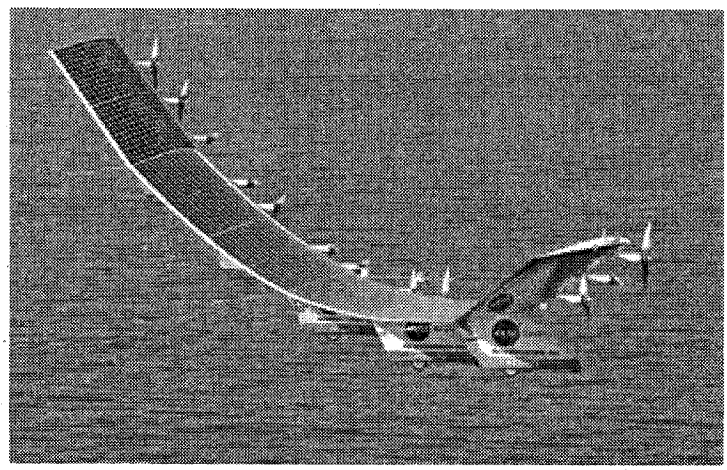
94 *Ibid.* (noting that the experiments included "the Orbital Reentry Experiment (OREX), performed in order to examine reentry into the Earth's atmosphere from orbit; the Hypersonic Flight Experiment (HYFLEX), performed to obtain data on aerodynamic heating and aerodynamic characteristics at hypersonic speeds over Mach 10; and the Automatic Landing Experiment (ALFLEX), performed to enable safe landing after a return to Earth").

95 See *e.g.* Craig Covault, "Ambitious Decade Ahead for Europe's Space Effort" *Aviation Week & Space Technology* 138:11 (15 March 1993) 88 (noting that "[i]ncreasing costs and decreasing mission requirements essentially killed Hermes")

96 See de Selding, "ESA, Russia to Collaborate," *supra* note 92 (reporting that the "ESA's principal member states, including France, Germany, Italy and Belgium, have all indicated that they want to participate in the development of a manned vehicle that would be capable of performing a range of missions in the post-shuttle era . . . [but] European government officials have said they will not embark on a solo development effort").

97 See generally ESA, "Project Objectives" *ESA Telecommunications Programme Development*, online: ESA <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=8188> [ESA, "Project Objectives"] (stating that "[u]nmanned stratospheric flight offers opportunities nearly as broad as space flight" and noting that "[h]igh altitude platform stations have already been accepted by International Telecommunication Union (ITU) as an alternative method of delivering the IMT-2000/UMTS (International Mobile Telecommunications System 2000/Universal Mobile Telecommunications System) services"). See also M. Rothblatt, "Are Stratospheric Platforms in Airspace or Outer Space?"

have the capability to operate in a "virtually unused" area termed "near space;" an altitude that is generally higher than what can be achieved by traditional aircraft, yet lower than the lowest perigee of orbiting satellites.[98] Both private industry and government programs are involved in research and development of various HAPS concepts.



Helios HAPS Aircraft[99]

Lockheed Martin was recently awarded a contract worth over $10 million by the Air Force Research Laboratory in connection with the Integrated Sensor IS Structure Program (ISIS), a project that is also being worked on by Northrop Grumman and Raytheon.[100] The ISIS will operate at altitudes above 70,000 feet (21.3 km), the program goal being "to develop a stratospheric, airship-based autonomous unmanned sensor with years of persistence in surveillance and tracking of air and ground targets [and] . . . the

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(1996) 24 J. Space L. 107 at 107 (defining a stratospheric platform as "a structure capable of maintaining its location over a specific portion of the Earth's surface for a multi-year lifetime, at an altitude of approximately 30 kilometers or higher").

98 See *e.g.* Leonard David, "Sky Trek to the 'Near Space' Neighborhood" *Space.com* (9 November 2005), online: Space.com <http://www.space.com/businesstechnology/051109_airships.html> [David, "Sky Trek"] (stating that "Near Space is between 65,000 feet (20 kilometers) and 325,000 feet (99 kilometers) above sea level").

99 NASA, "Fact Sheets: Helios Prototype" *Dryden Flight Research Center*, online: NASA <http://www.nasa.gov/centers/dryden/news/FactSheets/FS-068-DFRC.html>.

100 Defense Department Documents and Publications, "AFRL Awards $10.2 Million Contract to Lockheed Martin," *Department of Defense US Air Force Releases* (22 June 2006) (Lexis).

capability to track the most advanced cruise missiles at a distance in excess of 370 miles and dismounted enemy combatants on the ground nearly 200 miles away."[101] Lockheed is also one of the contractors (along with the Aeros Corporation) on the DARPA's Walrus project, which is a program "to develop and evaluate a very large airlifter . . .[capable of] moving loads of up to 1,000 tons across international distances."[102]

HAPS are not limited to military applications, but will also be used in other areas, such as communications, freight/cargo, and environmental monitoring.[103] Space agencies such as ESA[104] and JAXA[105] have programs researching HAPS concepts. Private entities are also involved in HAPS research, with companies such as Millennium Airship Incorporated and Sanswire Networks LLC working toward HAPS designs that will be used for heavy lift and communications purposes respectively.[106]

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[101] *Ibid.*

[102] David, "Sky Trek," *supra* note 98.

[103] See generally Coppinger, "Europe Set to Fly Internet Airship" *Flight International* (1 November 2005) (Lexis) (reporting that "work is being carried out under the €6 million ($7.2 million) European Union Sixth Framework research project Capanina, which aims to develop a high-altitude airship able to transmit broadband internet data to stationary and moving users, at rates of up to 120Mb/s"); U.S. *Unmanned Aerial Systems in Alaska: Hearing Before the Senate Committee on Commerce, Science and Transportation* (13 July 2006) (testimony of John W. Madden, Deputy Director, State of Alaska Department of Homeland Security) (Lexis) (testifying as to the benefits of testing Unmanned Aerial Systems in Alaska and noting "a clear need to examine the possibility of unmanned aerial systems achieving many missions on one flight - for science, safety, and security" as well as using such systems to monitor events with environmental impact such as fires and volcanoes). See also "Airships: Return of the Blimp" *The Engineer* (22 May 2006) at 28 (Lexis) (describing the increased interest in developing high altitude airships and noting that the U.S. Missile Defense Agency awarded Lockheed Martin a $150 million contract to develop a high altitude airship).

[104] See generally ESA, "Project Objectives," *supra* note 97 (discussing ESA's plans regarding a HAPS for communications purposes).

[105] See generally JAXA, "Next Generation Airplane: Stratospheric Platform (SPF)" *Projects: Space and Aeronautic Engineering Research*, online: JAXA <http://www.jaxa.jp/missions/projects/engineering/aero/next/index_e.html> (providing an overview of JAXA's stratospheric platform research); David, "Sky Trek," *supra* note 98 (discussing JAXA's "Stratosphere Platform Project").

[106] See *e.g.* David; "Sky Trek," *supra* note 98 (reporting on Millennium Airship's 'Sky Freighter' and Sanswire's 'Stratellite' HAPS concepts).

3. *The Space Elevator*

A space elevator is also exactly what the name suggests – an elevator extending from the surface of the Earth to outer space – "a physical connection from the surface of the Earth to the GEO."[107] The basic concept consists of a cable with one end fixed to a point along the equator on the Earth and the other end extending upwards to the GEO, where the "elevator center-of-mass station" is located.[108] The cable then extends beyond the GEO, to a total distance of about 100,000 km from the Earth's surface; the additional distance is for the purpose of counterbalancing the elevator.[109] The elevator vehicle would climb the cable by means of electromagnetic propulsion.[110]

Once developed, it is anticipated that space elevators will dramatically reduce the cost of getting passengers and payloads into orbit. NASA believes that space elevators are "one of very few concepts that may allow Earth to orbit launch costs less than $10/kg;"[111] a dramatic decrease in prices that currently average between $10,000-

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[107] D.V. Smitherman, Jr., cmpl., "Space Elevators: An Advanced Earth-Space Infrastructure for the New Millennium" *Advanced Space Infrastructure Workshop on Geostationary Orbiting Tether "Space Elevator" Concepts, NASA Marshall Space Flight Center, June 8–10, 1999* (Huntsville, AL: NASA, 2000) at 3.

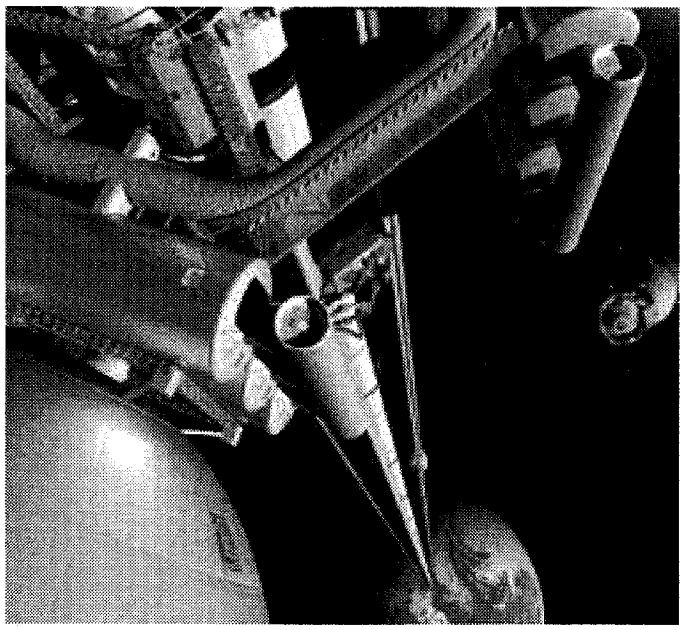
[108] *Ibid.* at 4. See generally Bradley C. Edwards & Eric A. Westling, *The Space Elevator: A Revolutionary Earth-to-Space Transportation System* (Houston, TX: BC Edwards, 2003) (providing an in-depth technical discussion of the space elevator concept based on Edward's research on the topic sponsored by the NASA Institute of Advanced Concepts).

[109] See generally Smitherman, Jr., *supra* note 107 at 4-5; Edwards, *supra* note 108 at 10, 45; Leonard David, "The Space Elevator Comes Closer to Reality" *Space.com* (27 March 2002), online: Space.com <http://www.space.com/businesstechnology/technology/space_elevator_020327-1.html> (noting "[t]he competing forces of gravity at the lower end and outward centripetal acceleration at the farther end keep the cable under tension" and it "remains stationary over a single position on Earth"). While the space elevator concept is generally discussed with the center-of-mass being located in the GEO, NASA concepts include the possibility of a LEO space elevator, having its center-of-mass in the LEO (approximately 2,000 km height as opposed to approximately 36,000 km for the GEO), which, it is asserted, would be easier to construct than a GEO space elevator, making it a more immediate possibility, although technology and theory involved and largely the same. See Smitherman, Jr., *supra* note 107 at 7-10 (discussing the LEO space elevator concept).

[110] See *e.g.* Smitherman, Jr., *supra* note 107 at 4 (discussing the "basics" of space elevators). While other means of propulsion are feasible, NASA sees electromagnetic propulsion as being preferable because it is a "non-contact" system. *Ibid.* at 14-15.

[111] Smitherman, Jr., *supra* note 107 at 29.

$20,000/kg.[112] Other benefits identified by NASA include increased access to space, a safer transportation system for fragile cargo, a means of transporting materials for large space-based constructions, access to transfer orbits, and environmental benefits.[113]



Space Elevator Concept[114]

While the concept of a space elevator is not new, until recently there was no known material strong enough to construct the cable, so, despite the solid physics, the idea remained in the realm of science fiction and speculation. However, recent developments in carbon nanotube technology have yielded a material that meets the strength requirements of a space elevator cable.[115] Because of carbon nanotubes,

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[112] Edwards, *supra* note 108 at 1.

[113] See Smitherman, Jr., *supra* note 107 at 29-30 (listing the benefits of space elevators and noting that they "could revolutionize space flight and space development").

[114] NASA, "The Next Giant Leap: The Science of Nanotechnology Could Lead to Radical Improvements For Space Exploration" *Science@NASA* (27 July 2005), online: NASA <http://science.nasa.gov/headlines/y2005/27jul_nanotech.htm.

[115] See generally Edwards, *supra* note 108 at 9 (noting that nanotubes are "probably the strongest material that can be produced" and are easily strong enough for space elevator technology); Smitherman, Jr., *supra* note 107 at 6-7 (discussing the materials needed for construction of the space elevator cable, and the potential use of carbon nanotubes); Sara Goudarzi, "Elevator Man: Bradley Edwards Reaches for the Heights" *Space.com* (18 February 2005), online: Space.com

construction of a space elevator is increasingly being seen as feasible in the not too distant future.[116]

One company that is currently working on developing space elevator technology is LiftPort, Inc. According to LiftPort:

> the space elevator will consist of a carbon nanotube composite ribbon stretching some 62,000 miles (100,000 km) from earth to space. The elevator will be anchored to a specially designed ocean going vessel named, "The LiftPort" near the equator in the Pacific Ocean, and to a small man-made counterweight in space. Lifters (robotic elevator cars) will move up and down the ribbon, carrying such items as satellites, solar power systems, exploration probes, factories, and eventually people into space. LiftPort's plan is to take the concept from the research stage to commercial development.[117]

LiftPort has been actively testing technology and, in February 2006, "successfully completed its second round of preliminary tests of its high altitude platform and robotic lifters."[118]

B. Commercialization of Space Activities

In recent years there has been a significant increase in private investment in space and commercial space activities. As space-related activities become increasingly

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<http://www.space.com/businesstechnology/technology/edwards_boldly_050218.html> (reporting that Edwards' company, Carbon Designs, Inc., is working to develop carbon nanotube technology).

116 See generally David Perlman, "An Elevator to Space? NASA Gives Idea A Lift; 12 Teams Vying for $100,000 in Prizes in Mountain View" *San Francisco Chronicle* (22 October 2005) B1 (reporting on NASA contests awarding monetary prizes to entrants for advancements in technology applicable to the space elevator, and noting that "NASA's ultimate goal – perhaps by 2020 – is the development of" a space elevator).

117 LiftPort, Inc., "About Us" *LiftPort.com*, online: LiftPort.com <http://www.liftport.com/index.php?id=14&PHPSESSID=bb6198e9e9cbf2ff64e37c70239fc725>.

118 "LiftPort Group, the Space Elevator Companies, Completes Second Round of Tests of Its Space Elevator Technology under FAA Waiver," *Business Wire* (13 February 2006) (Lexis). During the second phase "LiftPort successfully launched an observation and communication platform a full mile in the air and maintained it in a stationery position for more than six hours while robotic lifters climbed up and down a ribbon attached to the platform. The platform, a proprietary system that the company has named "HALE" (High Altitude Long Endurance), was secured in place by an arrangement of high altitude balloons, which were also used to launch it." *Ibid.*

commercially viable and accessible to the public, we are moving further from the days when governments (as the major source of funding) had *de facto* control over developments in space technology, as well as control over access to space.[119]

Today, fueled by various prizes and the emerging space tourism market, several companies are working to develop private spacecraft. Private spaceports are currently in the development stages at several international locations, made possible through a combination of private and public funding.

1. The Increasing Importance of Private Space Ventures

Governments are not, generally speaking, in the commercial space business. National space agencies must compete for their portion of the annual budget with other governmental programs and agencies, and even when funding is secured, projects are still subject to the political process, budget cuts, and early termination.[120] The increasing recognition by government that it cannot and should not try to do everything in space, and do it all itself, has led to proposals for private partnerships and government-sponsored prizes for technological developments in various space exploration areas.[121] NASA is offering significant funding to commercial ventures through prizes and other means, with the goal of having private industry take over functions that have been

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[119] See generally Martin Redfern, "Human Spaceflight Goes Commercial" *BBC.com* (21 March 2006), online: BBC.com <http://news.bbc.co.uk/1/hi/sci/tech/4828404.stm> (noting "[l]aunching people into space has until now been the almost exclusive preserve of superpower governments. But, according to industry experts and entrepreneurs, the commercial exploitation of space is about to open a new frontier for mass tourism").

[120] See generally Sietzen, Jr. & Cowing, *supra* note 7 at 123-46 (describing the impacts of political and budgetary factors in NASA's attempts to develop a spaceplane replacement for the Shuttle).

[121] See generally Frank Morring, Jr., "Moon Milestones; Industry to Have Role in Plotting Lunar Exploration; Public-Private Investment Capital Pool is Sought" *Aviation Week & Space Technology* 164:8 (20 February 2006) 39 (discussing NASA's programs for partnership with private industry, noting that "NASA will play the role of an investor, and winning bidders will most likely own any hardware that results . . . the approach is designed to encourage contractors to put some 'skin in the game' in terms of their own investments and risk, and NASA is forfeiting some normal government oversight as a result," and quoting NASA Administrator Michael Griffin as stating "[s]ooner rather than later, government space activity must become a lesser rather than a greater part of what humans do in space").

exclusively NASA's,[122] as well as encouraging private industry to develop technologies that will be needed for future NASA missions[123]. NASA's "Centennial Challenges program creates specialized competitions that will further the exploration of space through specific technological development beyond the usual federal procurement process."[124] Future prize competitions under the Centennial Challenges program are slated to include the X-Cup Altitude Challenge, which will "reward development of a reusable suborbital launch vehicle that can carry a payload to sufficient altitudes for conducting space experiments," and the Suborbital Lunar Landing Analog Challenge, which "will promote development of reusable suborbital vertical takeoff, vertical landing vehicles that can reach certain to-be-determined speeds in order to mimic the technology needed to land and take off from the Moon."[125] Another three possible future Centennial Challenges related to spaceflight are "competitions for an orbital crew transport vehicle, cryogenic storage and transfer technologies for inspace propellant provisioning, and the launch of a small lunar lander that could carry a certain amount of weight to the Moon at a fraction of the current cost."[126]

In addition to sources of government funding designed to stimulate the commercial space industry, private organizations are also offering prizes for new developments in space technologies. The $10 million, privately funded X-Prize, claimed by Scaled Composites for the successful flight of SpaceShipOne in October 2004, can be at least partially credited with kick-starting the commercial space industry after it was

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122 See *e.g.* Frank Morring, Jr., "Commercial Launch" *Aviation Week & Space Technology* 163:23 (12 December 2005) 17 (reporting "NASA will spend $40 million in the current fiscal year and another $130 million in Fiscal 2007 on commercial launches to the International Space Station (ISS), part of a $500-million wedge that could give spaceflight entrepreneurs enough seed corn to begin harvesting profits from orbit").

123 See especially NASA, "NASA's Centennial Challenges" *NASA Exploration Systems*, online: NASA <http://exploration.nasa.gov/centennialchallenge/cc_index.html> (listing the current Centennial Challenges topics and prizes, and describing the program as "NASA's program of prize contests to stimulate innovation and competition in solar system exploration and ongoing NASA mission areas").

124 FAA/AST, "2006 Commercial Space Developments," *supra* note 33 at 7.

125 *Ibid.* at 8

126 *Ibid.*

announced in 1996.[127] Following the success of the X-Prize, an annual event, the X-Prize Cup, was established. In addition to providing a forum for teams that are competing for the annual X-Prizes, the X-Prize Cup is designed to promote the commercial space industry by creating an environment that showcases new developments and ideas.[128] America's Space Prize, sponsored by Bigelow Aerospace is raising the stakes and increasing the challenge by offering $50 million to the first team to develop a spacecraft capable of carrying 5-7 passengers into orbit prior to January 2010.[129]

The cumulative significance of the various sources of funding available is that it demonstrates there are billions of dollars available to participants in the commercial space industry and there is interest in having space technologies developed by the private sector. The availability of funds, increasing investment, and business development interest in the commercial space sector is reflected by the economic growth associated with commercial space transportation.

According to a study done by the FAA/AST, the economic activity impacts of commercial space transportation and enabled industries exceeded $98 billion in 2004, which was an increase of over $37 billion from 1999.[130] The FAA/AST study also identified emerging markets, enabled by commercial space transportation, which are predicted to have a significant economic impact in the future.[131] These markets include

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127 See generally X-Prize Foundation, "History of the X-Prize," online: X-Prize Foundation <http://www.xprizefoundation.com/about_us/history.asp> (describing the history and purpose of the X-Prize); Paula Berinstein, *Making Space Happen: Private Space Ventures and the Visionaries Behind Them*, (Medford, NJ: Plexus, 2002) at 122-36 (discussing the X-Prize and its founder, Peter Diamandis).

128 See especially X-Prize Foundation, "X-Prize Cup," online: X-Prize Foundation <http://www.xpcup.com/index.cfm> (providing general information on the X-Prize Cup).

129 See generally Bigelow Aerospace, Inc., "America's Space Prize: Ten Primary Rules of the Competition," online: Bigelow Aerospace, Inc. <http://www.bigelowaerospace.com/space_prize.htm>; Craig Covault, "Bigelow's Gamble; It's a High-Stakes Game to Develop Commercial Inflatable Space Modules While Proposing a $50-Million Prize for a New Piloted Spacecraft to Service Them" *Aviation Week & Space Technology* 161:12 (27 September 2004) 54 (reporting the plans for America's Space Prize).

130 FAA/AST, "The Economic Impact of Commercial Space Transportation on the US Economy: 2004" (February 2006), online: FAA/AST <http://ast.faa.gov/files/pdf/Ecoimpactreportweb06.pdf>.

131 *Ibid.*

public space travel (space tourism), real-time remote sensing applications, and broadband data services.[132]

2. *The Emerging Space Tourism Industry*

Dennis Tito, the world's first space tourist, paid the Russians $20 million for a ride to the ISS aboard a Soyuz capsule.[133] Since Tito's flight two more space tourists, Mark Shuttleworth and Gregory Olsen, have also come up with the $20 price tag for a trip to the ISS aboard a Soyuz, and others are interested in making the journey.[134] Daisuke Enomoto is scheduled to visit the ISS in October 2006[135] and, most recently, Charles Simonyi has signed up for the trip.[136] By the year 2021 it is projected that over 15,000 people per year will participate in suborbital travel and the suborbital industry will bring in almost $800,000 million in annual revenue.[137] For orbital travel the 2021 projections are 60 people participating per year, with an annual revenue of $300,000 million.[138]

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[132] *Ibid.* (noting, with respect to the space tourism industry, that "[r]ecent market studies have shown that public space travel has the potential to become a billion-dollar industry within 20 years. Moreover, public space travel may provide the initial market for suborbital vehicles that can also serve other markets, including microgravity research, remote sensing, and fast package delivery").

[133] See *e.g.* Peter Baker, "American Fulfills Joy-Ride Dream; Russian Rocket Lifts Tourist Into Space" *Washington Post* (29 April 2001) A17 (reporting on Tito's historic trip to the ISS).

[134] See *e.g.* "South African Lifts Off" *New York Times* (26 April 2002) A8 (reporting on Shuttleworth's launch into space); "Crew and Tourist Head Into Space" *New York Times* (2 October 2005) A31 (reporting on Olsen's launch into space).

[135] See *e.g.* Bjorn Carey, "Space Adventures Announces Next Private Space Explorer" *Space.com* (3 November 2005), online: Space.com <http://www.space.com/news/051103_enomoto_adventure.html> (reporting that Enomoto will become the fourth space tourist).

[136] See *e.g.* Chris Noon, "Billionaire Simonyi Signs Up for Space Travel" *Forbes.com* (5 April 2006), online: Forbes.com <http://www.forbes.com/2006/04/05/simonyi-billionaires-space-cx_cn_0405autofacescan02.html> (reporting Simonyi has signed up for a trip to the ISS).

[137] Futron Corporation, "Space Tourism Market Study: Orbital Space Travel & Destinations with Suborbital Space Travel" (October 2002) at 52, online: Futron Corporation <http://www.futron.com/pdf/SpaceTourismMarketStudy.pdf>. The projected cost of a suborbital trip in 2021 is $50,000. *Ibid.*

[138] *Ibid.* at 59. The projected cost for an orbital trip in 2021 is $5 million. *Ibid.*

Space tourism is a growing industry, with several specialized companies entering the orbital and suborbital tourism market.[139] Virgin Galactic has put in an order for a fleet of five SpaceShipTwo suborbital craft and plans to start its suborbital tourism flights in 2008-09.[140] Although it has yet to fly anyone into space, Virgin Galactic has collected over $13 million from prospective passengers who have signed up for the $200,000 suborbital flights, which will take them to an altitude of about 110 km.[141] Space Adventures, meanwhile, is the only company that, so far, has actually put anyone in space; to date it has brokered all the orbital space tourism deals with the Russians for transport to the ISS aboard a Soyuz.[142] Space Adventures is also looking to get into the suborbital tourism market and, to that end, has associated itself with suborbital vehicle designers and manufacturers,[143] and has also announced plans to build two private spaceports.[144] Space Adventures also currently offers zero-g flights and flights to the

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139 See generally "Space Travel Price No Longer Out of This World," *supra* note 45 (describing the growing space tourism industry); Leonard David, "Space Tourism: Marketing to the Masses" *Space.com* (6 June 2005), online: Space.com <http://www.space.com/adastra/050606_isdc_tourism.html> (discussing the space tourism industry); Michel Van Pelt, *Space Tourism: Adventures in Earth Orbit and Beyond* (New York: Praxis, 2005) (generally discussing space tourism and providing an in-depth look at various aspects).

140 See *e.g.* Peter de Selding, "Virgin Galactic Customers Parting With Their Cash" *Space.com* (3 April 2006), online: Space.com <http://www.space.com/spacenews/businessmonday_060403.html>.

141 *Ibid.*

142 See *e.g.* Chris Taylor, "Hurtling Into the Space Tourism Industry: Space Adventures is Leaping Ahead of Well-Known Rivals in the Race to Launch Regular Joes Into Space" *Business 2.0* (30 March 2006), online: CNN.com <http://money.cnn.com/2006/03/30/technology/business2_futureboy0330/> (noting that "Space Adventures, which owns the rights to sell seats aboard Russia's Soyuz rockets" is responsible for all the space tourists to date and "is the only outfit that's ever sold a space tourism package").

143 See especially Space Adventures Ltd., "Space Tourism Pioneers," *supra* note 65 (regarding the development of the Explorer spacecraft); Space Adventures Ltd., "XCOR and Space Adventures Announce New Suborbital Spacecraft" *Space Adventures Press Releases* (22 July 2002), online: Space Adventures <http://www.spaceadventures.com/media/releases/2002-07/68> (announcing "a marketing agreement that enables Space Adventures to offer the first 600 flights . . . aboard XCOR's Xerus suborbital vehicle, designed specifically for space tourist flights").

144 See *e.g.* Taylor, *supra* note 142 (reporting "Space Adventures has announced plans to build a spaceport in Singapore, less than a month after it announced earlier plans to build one in the United Arab Emirates").

edge of space aboard a Russian Mig-25.[145] Finally, for $100,000,000 Space Adventures, through an exclusive contract with the FSA and RSC Energia, is offering the DSE-Alpha Mission – a trip around the far side of the moon – which could take place as early as 2008 and is expected to launch by 2010.[146]

Many other companies have also entered the space tourism industry. Zero Gravity Corporation conducts parabolic zero-g flights using a 727-200, allowing passengers to experience weightlessness similar to what astronauts feel while in outer space.[147] Starchaser Industries Limited, a rocket developer, plans to use its rockets to offer orbital flights.[148] Planetspace, partnered with rocket designer/manufacturer Canadian Arrow, expects to offer $250,000 suborbital flights in the near future, predicting they will "fly 2,000 new astronauts in the first five years and generate revenue of $200 million U.S. in the fifth year."[149] Bigelow Aerospace is developing inflatable space station modules, based on NASA's cancelled TransHab project, that will be used as an orbital space hotel.[150] Incredible Adventures has partnered with Rocketplane-Kistler

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145 See especially Space Adventures, Ltd., "Steps to Space," online: Space Adventures, Ltd. <http://www.spaceadventures.com/steps> (describing near-space experiences offered by Space Adventures).

146 See especially Space Adventures, Ltd., "Space Adventures Offers Private Voyage to the Moon" *Space Adventures Press Releases* (10 August 2005), online: Space Adventures, Ltd. <http://www.spaceadventures.com/media/releases/2005-08/284> (announcing the availability of the lunar trip and quoting Eric Anderson, CEO of Space Adventures, as saying, based on the level of interest shown so far, "I have no doubt that we'll launch DSE-Alpha by 2010").

147 Zero Gravity Corporation, "About Us: History," online: Zero Gravity Corporation <http://www.gozerog.com/home_full1.aspx> (describing the history of Zero Gravity Corporation and the zero-g flights).

148 Starchaser Industries Limited, "Ride Into Space," online: Starchaser Industries Limited <http://www.starchaser.co.uk/index.php?view=space_ride&mgroup=tourists> (describing the space tourism experience Starchaser plans to offer).

149 Planetspace, "About Planetspace," online: Planetspace <http://www.planetspace.org/lo/about.htm> (discussing the space tourism goals of Planetspace).

150 See *e.g.* Michael Belfiore, "The Five-Billion Star Hotel" *Popular Science*, online: Popular Science <http://www.popsci.com/popsci/technology/generaltechnology/2f8965e919d05010vgnvcm1000004eecbccdrcrd.html> (reporting on Bigelow Aerospace's plans to develop a space hotel).

and plans to provide suborbital flights aboard the Rocketplane XP.[151] Spacetopia, based in Japan, plans to offer space tourism packages in the future[152]

Based on the results of internal studies, ESA has decided to become more directly involved with the development of the European space tourism industry.[153] To that end, the ESA recently announced a program "to help up to three private companies develop business plans to get their space tourism ventures off the ground."[154] The program, officially titled 'The Survey of European Privately-funded Vehicles for Commercial Human Spaceflight,' is administered through the ESA's General Studies Programme, and will "critically review the spacecraft design and mission profiles [contained in the three selected proposals], ensuring they are technically feasible, and develop sound business plans in order to allow companies to approach potential investors."[155] The ESA hopes its involvement with the space tourism industry will "provide interesting inputs to ESA's technology programmes, while at the same time establish links between ESA and the space tourism industry."[156]

3. *Private/Commercial Spaceports*

Just as the commercial airline industry would not exist without airports, the commercial space industry will need spaceports. Once exotic locales described in the pages of science fiction novels, spaceports are now the subject of high-level negotiations

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[151] See Incredible Adventures "Suborbital Space Flights," online: Incredible Adventures <http://www.incredible-adventures.com/sub-orbital.html> (listing suborbital flights aboard the Rocketplane XP as one of the offered adventures); Edwards, "RLV Challenges," *supra* note 45 (reporting on the partnership between Rocketplane and Incredible Adventures).

[152] Spacetopia, Inc., "Company Profile," online: Spacetopia, Inc. <http://www.spacetopia.com/> (stating "Spacetopia, Inc. has been established to exploit the emerging market for space tourism and related services in Japan").

[153] ESA, "ESA to Help Europe Prepare for Space Tourism" *ESA News* (21 July 2006), online: ESA <http://www.esa.int/esaCP/SEMNYIBUQPE_index_0.html> (noting that "[t]his is the first time an ESA study aims to involve private companies working in the development of crewed space vehicles for the space tourism market").

[154] *Ibid.*

[155] *Ibid.* (noting that each of the three selected companies "will receive 150,000 Euro to further develop their plans").

[156] *Ibid.*

and multi-million dollar deals. In the U.S. spaceports must be licensed by the FAA/AST; currently there are five licensed spaceports.[157] Development plans for additional spaceports, in the U.S. and internationally, are presently underway.

In December 2005 Virgin Galactic and New Mexico Governor Bill Richardson announced an agreement under which Virgin Galactic will locate its headquarters and operations center at a spaceport to be built in New Mexico.[158] With financial backing from the New Mexico state government, the Southwest Regional Spaceport, to be located near Las Cruces, New Mexico, is on its way to becoming the world's first totally commercial spaceport.[159] Construction has not yet begun on the spaceport, which is still awaiting FAA/AST approval – expected in late 2006.[160] Despite the fact that not much has yet been built on the 27 square miles of land, Virgin Galactic is not the only company setting up shop in the New Mexico desert. Starchaser Industries, UP Aerospace, the Rocket Racing League, and the X-Prize Cup are now located in, or have facilities in, the area of the future spaceport.[161]

Other U.S. locations are also seeking to become the home of future commercial spaceports. Oklahoma, home of Rocketplane-Kistler, "is in the final stages of obtaining a

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[157] FAA/AST, "Launch Site Operator Licenses Issued = 5" *Licensing Regulations & Regulatory Activity: Current Licenses*, online: FAA/AST <http://ast.faa.gov/lrra/current_licenses.cfm> (listing the currently licensed spaceports in the U.S.).

[158] See *e.g.* Leonard David, "Virgin Galactic Sets Deal With New Mexico Spaceport" *Space.com* (13 December 2005), online: Space.com <http://www.space.com/news/051213_virgin_galactic.html> (reporting Virgin Galactic "has worked a deal with New Mexico that involves a 20-year lease on the spaceport, a facility that is price tagged at $225 million to build"). Three other states, California, Florida and Texas, had also been competing to be the site of a spaceport and Virgin Galactic's headquarters. See *e.g.* T.R. Reid, "N.M. Plans Launchpad for Space Tourism; Construction Set To Start in 2007 on $250 Million Port" *Washington Post* (15 December 2005) A3.

[159] See T.R. Reid, *supra* note 158 (reporting on New Mexico's commitment "to building the world's first commercial 'spaceport,' a 21st-century airport to serve scheduled flights carrying passengers and cargo on suborbital spaceflights"); Heath Haussamen, "Richardson Signs Spaceport Bills Into Law" *Las Cruces [New Mexico] Sun-News* (2 March 2006) 1A (reporting that in addition to "$110 million in spaceport funding approved by the legislature last month," legislation passed creating the New Mexico Spaceport Authority and providing additional sources of funding for the Southwest Regional Spaceport).

[160] See *e.g.* Leonard David, "New Mexico: Building a Better Spaceport" *Space.com* (25 January 2006), online: Space.com <http://www.space.com/businesstechnology/060125_build_spaceport.html>.

[161] *Ibid.*

spaceport license" for Clinton-Sherman Industrial Airpark.[162] The Florida Space Authority commissioned a commercial spaceport feasibility study,[163] the Governor's Commission on the Future of Space and Aeronautics in Florida has recommended that a commercial spaceport be considered,[164] and Florida Governor Jeb Bush included $55 million to boost the Florida space industry in his 2006-07 budget request.[165] Other states considering commercial spaceports include Alabama, Texas, Washington, and Wisconsin.[166]

Alabama is planning "a full-service departure and return facility supporting orbital and suborbital space access vehicles," including

> a departure and return facility, processing and support facilities, and full support infrastructure. An R&D park, a commerce park, supporting community infrastructure, intermodal connectivity, and other services and

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[162] Molly McMillin, "Oklahoma: Gateway to the Final Frontier?" *Wichita [Kansas] Eagle* (16 April 2006) (Lexis). See also FAA, AST "Final Environmental Assessment for the Oklahoma Spaceport" (May 2006), online: FAA/AST <http://ast.faa.gov/pdf/lrra/20060505Final%20EA%20for%20Oklahoma%20Spaceportdksv3c.pdf> (describing the Oklahoma Spaceport as a facility for "launching horizontally-launched, suborbital vehicles" and noting "[c]ustomers operating under a launch license may use the facility to provide for-profit launch services including tourism activities [and] [c]ustomers operating under an experimental permit may use the facility to conduct research, development, and testing of [RLVs]"). The Oklahoma Spaceport was issued a Launch Site Operator License on 12 June 2006, officially joining the ranks of licensed commercial spaceports. See Leonard David, "State Spaceports Grow in Number" *Space.com* (16 June 2006), online: Space.com <http://www.space.com/news/060616_spaceports_update.html> (quoting Chuck Lauer, a VP with Rocketplane, as noting that "[t]his is the first time that an overland space flight launch corridor has ever been approved outside of restricted military air space, and it means that commercial human space flight is now open for business in Oklahoma") [footnote internal quotes omitted].

[163] Florida Space Authority (Futron Corporation), "Feasibility Study: A Florida Commercial Spaceport," online: Florida Space Authority <http://www.floridaspaceauthority.com/press/images/futron_full_report_final.pdf> (providing a full copy of the study).

[164] See *e.g.* J. Taylor Rushing, "Cecil Not Specified in Space Report; But State Panel Does Urge Consideration of a Commercial Launch Site with a Long Runway" *Florida Times-Union* (19 January 2006) B1 (reporting on Florida governmental discussions regarding commercial spaceport development).

[165] See *e.g.* Paige St. John, "Jeb Seeks $55 Million for Space" *Florida Today* (19 January 2006) A1 (detailing the $55 million budget request and the areas where the money is to be spent, "including planning a commercial spaceport geared to support horizontal launches").

[166] See FAA/AST, "2006 Commercial Space Developments," *supra* note 33 at 55 (listing proposed non-federal spaceports).

> infrastructure necessary for providing a "turn key" capability in support of space commerce, R&D, national security, science, and related services are also included in this plan.[167]

Texas, a state with a number of geographically-organized spaceport development authorities,[168] currently has two spaceport proposals before the FAA, one of which would be on land privately owned by the founder of the space tourism company Blue Origin.[169] Wisconsin has established the Wisconsin Aerospace Authority, which is authorized to sell $100 million in revenue bonds to fund the construction of a commercial spaceport in Sheboygan.[170] The site is already authorized to conduct suborbital sounding rocket launches and has existing functional infrastructure including "a vertical pad for suborbital launches in addition to portable launch facilities, such as mission control, which are erected and disassembled as needed."[171] Spaceport Washington is proposing that Grant County International Airport, a former Air Force base, be the site of a future spaceport to be used "for horizontal and vertical take-offs and horizontal landings of all classes of RLVs."[172] Meanwhile, California, site of the existing Mojave spaceport, is considering a bill which would provide an $11 million loan to the spaceport to build improved facilities for the growing space tourism industry; facilities it is hoped will prevent such businesses from being lured away to spaceports in other states.[173]

Commercial spaceports are not merely a U.S. phenomenon. Both Space Adventures and Virgin Galactic have plans to develop spaceports in several international

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167 *Ibid.* at 58.

168 See *e.g.* Fernando Del Valle, "Spaceport Project Languishing: Officials Say Cut Ties Among Leaders the Cause of Stall" *Valley Morning Star [Texas]* (3 April 2006) (Lexis) (describing the push for spaceports in Texas).

169 See *e.g.* "After Bust, States Eying the Spaceport Business Again" *The [Annapolis] Capital* (14 May 2006) A5 (reporting on states' growing interest in spaceport development).

170 See *e.g.* Foster, "Sheboygan: Hold the 'Beam Me Up' Jokes" *Milwaukee Journal Sentinel* (15 May 2006) A10; Dan Egan, "Sheboygan's Space Odyssey; City Can Compete in the Spaceport Business, Rocket Launch Boosters Say" *Milwaukee Journal Sentinel* (27 December 2005) A1 (reporting on the possibility of developing a spaceport in Wisconsin).

171 FAA/AST, "2006 Commercial Space Developments," *supra* note 33 at 60.

172 *Ibid.* at 58.

173 See *e.g.* Judy Lin, "Bill Seeks Loan for Spaceport in South State" *Sacramento Bee* (7 May 2006) (Lexis).

locations.[174] In February 2006 Space Adventures announced plans to develop commercial spaceports in the UAE and Singapore.[175] Local governments in both locations support the projects, which will be more than simple take-off and landing points for suborbital flights in Space Adventures' Explorer spacecraft.[176] For example, Space Adventures has announced the Singapore spaceport will include options such as "parabolic flights that will allow passengers to experience the thrill of weightlessness, G-force training in a centrifuge . . . simulated space walks . . . [flights] in a variety of jet aircraft . . . flight simulators and interactive exhibit experiences."[177]

C. Chapter Summary

The development of space technology, until recently, has been almost exclusively dictated by the needs of State run space programs, which, also until recently, were the only means of access to space. The end of the Cold War, which brought an end to the political climate that shaped the space age and the course of development of space technology, coincided with the beginnings of a growing interest in the commercial development of space and space technologies. An increasing commercial sector presence in space, the private development of space transportation technologies, and the ability of

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174 See *e.g.* Oliver Harvey, "Blast Resort" *The Sun [England]* (19 May 2006) (Lexis) (reporting Virgin Galactic has plans to develop spaceports in Scotland and Sweden); "UK Virgin Galactic To Run Space Tourism from Swedish Kiruna" *Swedish Business Digest* (9 May 2006) (Lexis) (stating Virgin Galactic "is planning to make the Esrange launch pad in Kiruna, northern Sweden, one of its bases for commercial space flights, starting in 2008").

175 See especially Space Adventures, Ltd., "Space Adventures Announces $265 Million Global Spaceport Development Project" *Space Adventures Press Releases* (17 February 2006), online: Space Adventures, Ltd. <http://www.spaceadventures.com/media/releases/2006-02/347> ["Spaceport Development Project"] (announcing the development plans for the UAE spaceport); Space Adventures, Ltd., "Space Adventures Announces an Integrated Spaceport Offering Suborbital Spaceflights, Astronaut Training and Interactive Visitor Center" *Space Adventures Press Releases* (20 February 2006), online: Space Adventures, Ltd. <http://www.spaceadventures.com/media/releases/2006-02/348> ["Integrated Spaceport"](announcing the Singapore spaceport development deal).

176 See especially Space Adventures, Ltd., "Spaceport Development Project," *supra* note 175 (stating the UAE spaceport "will be funded by various parties, along with shared investments by Space Adventures and the government of Ras Al-Khaimah" and that the government and "UAE Department of Civilian Aviation, have granted clearance to operate suborbital spaceflights in their air space"); Space Adventures, Ltd., "Integrated Spaceport," *supra* note 175 (stating the project has the support of all the necessary agencies in Singapore).

177 Space Adventures, Ltd., "Integrated Spaceport," *supra* note 175.

private entities to reach space without government assistance, combined with significant advancements in the space technology itself, are changing the face of space exploration.

Fundamental changes to the nature of space exploration and technological advancements that could not have been foreseen at the beginning of the space age do not occur in a vacuum, but rather have an inevitable effect on the structure that developed around the old, State-dominated system of space exploration. The assumptions, laws, rules and regulations that applied to space and space technology in the formative, State-run years of the space age, may no longer be the most appropriate to govern the field as the space age progresses into its second half-century.

CHAPTER II.

AN UNRESOLVED QUESTION: THE AIR/SPACE BOUNDARY

The question has been asked since the beginning of the space age – where does airspace end and outer space begin? Despite the nearly 50 years since the launch of Sputnik and the perpetual consideration given to the question by the COPUOS, the boundary question remains unanswered. Under international law there are unquestionably two separate and distinct regions, airspace and outer space, which are governed by two separate and distinct bodies of law. Although logic would suggest that there must be a dividing point between those two regions (after all, if there was not, why bother differentiating airspace from outer space), States have not yet been able to agree on the location of this boundary, or even whether there is a need for such a boundary.

A. Airspace and Outer Space from a Scientific Perspective

From a scientific perspective the atmosphere is simply the blanket of gasses that surround the Earth. The atmosphere is not, however, comprised of a single, uniform layer, but is divided into five distinctive layers referred to as the troposphere, stratosphere, mesosphere, thermosphere, and exosphere.[178] The boundary between layers, the 'pauses,' are areas "where the maximum changes in thermal characteristics, chemical composition, movement, and density occur."[179]

The troposphere, containing approximately 75% of the air mass,[180] extends from the surface of the Earth to a height of 6-20 km, depending on location.[181] The

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[178] See generally NOAA, "Layers of the Atmosphere" *Jetstream: An Online School for Weather*, online: NOAA <http://www.srh.noaa.gov/srh/jetstream/atmos/layers.htm> (describing the various layers of the atmosphere).

[179] *Ibid.* The boundary between the troposphere and the stratosphere is the tropopause, between the stratosphere and the mesosphere is the stratopause, and so on. The altitudes given for each level of the atmosphere in the next paragraph are approximations; there are no hard line boundaries and the altitude can vary in different geographical locations.

[180] See *e.g.* Robert F.A. Goedhart, *The Never Ending Dispute: Delimitation of Air Space and Outer Space* (Gif-sur-Yvette Cedex, France: Editions Frontières, 1996) at 22.

[181] See generally NOAA, *supra* note 178.

stratosphere, which is less dense than the troposphere, begins at the top of the troposphere and extends to a height of approximately 50 km.[182] The troposphere and stratosphere combined contain about 99% of what we refer to as 'air.'[183] The mesosphere, the coldest region of the atmosphere, extends to a height of about 85 km.[184] Once in the thermosphere, which extends to a height of about 600 km, the temperature increases with altitude and the gasses continue to thin.[185] Finally, the exosphere, composed primarily near-negligible quantities of helium and hydrogen, extends to an altitude of about 10,000 km.[186]

In looking at the composition of the atmosphere, it is clear 'atmosphere' and 'airspace' are not synonymous. The specific combination of gasses making up air are confined to the lower levels of the atmosphere and most aircraft operate exclusively within the troposphere. Commercial aircraft have a cruising altitude of approximately 10.6 km (35,000 ft).[187] With a cruising altitude of 18.3 km (60,000 ft), the Concorde had the highest cruising altitude of any commercial aircraft.[188] The SR-71 Blackbird holds the record for the highest service ceiling of any operational military aircraft at (at least) 26 km (85,500 ft), therefore reaching only slightly into the stratosphere.[189] The MiG-25,

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182 *Ibid.*

183 See generally NASA, "Earth's Atmosphere" *Exploration*, online: NASA <http://liftoff.msfc.nasa.gov/academy/space/atmosphere.html> (describing the various layers of the atmosphere).

184 See generally NOAA, *supra* note 178.

185 *Ibid.*

186 *Ibid.*

187 See generally Boeing, "777-200/-200ER Technical Characteristics" *777 Family*, online: Boeing <http://www.boeing.com/commercial/777family/pf/pf_200product.html> (listing the cruising altitude of the 777-200 as 35,000 ft.); Boeing, "Technical Characteristics – Boeing 747-400" *747 Family*, online: Boeing < http://www.boeing.com/commercial/747family/pf/pf_400_prod.html> (listing the cruising altitude of the 747-400 as 35,000 ft.).

188 British Airways, "About Concorde: Concorde Facts and Figures" *Celebrating Concorde:1976-2003*, online: British Airways <http://www.britishairways.com/concorde/aboutconcorde.html#facts_figures> (listing the cruising altitude of the Concorde as "up to 60,000 ft").

189 See *e.g.* USAF, "SR-71A 'Blackbird'" Air Force Link, online: USAF <http://www.af.mil/history/aircraft_print.asp?storyID=123006569> (listing the service ceiling of the SR-71 as "plus 85,000 feet"); Aerospace Web, "Lockheed SR-71 Blackbird" *C4ISRT Gallery*, online: Aerospace Web <http://www.aerospaceweb.org/aircraft/recon/> (listing the SR-71 as the record-holder

which has been recognized as holding the absolute altitude record for aircraft, has reached 37.6 km (123,524 ft), or about halfway into the stratosphere.[190] Scramjet technology, which has been tested on the X-43 and is still only experimental, is designed to function at altitudes that cannot support traditional air-breathing jet engines.[191] NASA scramjet tests were conducted at altitudes above 90,000 ft (27.4 km), still well within the stratosphere.[192]

Approaching the matter from another angle, it is also clear outer space and the atmosphere are not mutually exclusive; many 'space' activities take place within the technical confines of the Earth's atmosphere. The Shuttle orbits the Earth at various altitudes, depending on mission requirements, but it was designed to orbit at altitudes between 185 km - 643 km (606,955 ft - 2,109,580 ft).[193] At these altitudes the Shuttle is primarily within the thermosphere and, at the highest of the altitudes, just slightly inside the exosphere.

In the U.S. 'astronaut wings' are given to those that surpass the 50 mile (80 km) mark,[194] which is near the boundary between the stratosphere and thermosphere. The

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for the highest operational ceiling at 85,500 ft, but noting "much of the capabilities of the SR-71 are still unknown").

190 See Space Adventures, Ltd., "Edge of Space: MiG-25" *Steps to Space*, online: Space Adventures, Ltd. <http://www.spaceadventures.com/steps/edge> (noting that on 31 August 1977 a MiG-25 "set the world's absolute altitude record for a ground-launched air-breathing aircraft," reaching a height of 118,867 feet). The optimal operational altitude for the MiG-25 is significantly lower than the record-breaking absolute altitude. See Aerospace Web, "Mikoyan Gurevich MiG-25" *Fighter Gallery*, online: Aerospace Web <http://www.aerospaceweb.org/aircraft/fighter/> (listing the MiG-25 service ceiling as 67,900 ft and noting it holds the absolute altitude record of 123,524 ft).

191 See Chapter I.A.1.a)(5), above, discussing the X-43 program.

192 See especially NASA, "NASA Hyper-X Program Demonstrates Scramjet Technologies: X-43A Flight Makes Aviation History" *NASA Facts* (20 October 2004), online: NASA <http://www.nasa.gov/pdf/67456main_X-43A_Fa.pdf> (reporting the Mach 7 test of the X-43 was conducted at 95,000 ft and the Mach 10 test was to be conducted at 110,000 ft).

193 See especially NASA, "Shuttle Basics" *Missions: Space Shuttle: Return to Flight* (5 March 2006), online: NASA <http://www.nasa.gov/returntoflight/system/system_STS.html>.

194 See generally NASA, "X-15 Space Pioneers Now Honored as Astronauts" *Dryden Flight Research Center: Dryden News* (23 August 2005), online: NASA <http://www.nasa.gov/centers/dryden/news/NewsReleases/2005/05-57.html> (reporting civilian NASA pilots who flew the X-15 in the 1960's were awarded astronaut wings, formerly only available to military personnel, in August 2005 in recognition of having surpassed the 50 mile altitude mark).

FAI (Fédération Aéronautique Internationale) uses the 100 km mark to separate aeronautics from astronautics.[195] The 100 km mark was also the altitude required (and surpassed) in order to claim the X-Prize; both SpaceShipOne pilots were awarded commercial astronaut wings by the FAA/AST.[196] This is not to suggest that all current space activities take place within the atmosphere. Satellites in the GEO, for example, are at an altitude of 35,786 km, well outside the exosphere.[197] Satellites in the MEO also can be outside the exosphere, with orbital altitudes between 8,000 km - 20,000 km.[198] In contrast, LEO satellites, with orbital altitudes between approximately 500 km - 2,000 km, are entirely within the Earth's atmosphere.[199]

The atmosphere does not have a sharp edge or a fixed point after which there is nothing but outer space. The exosphere extends about 10,000 km outwards from the Earth's surface where it gradually dissipates into space, but that altitude is only

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[195] See especially Sanz Fernández de Córdoba (FAI), "100 km Altitude Boundary for Astronautics" *FAI Astronautic Records Commission* (21 June 2004), online: FAI <http://www.fai.org/astronautics/100km.asp> (noting that around the 100 km altitude mark is where "things change" with respect to the ability to orbit the Earth). Founded in 1905, the FAI has over 100 member countries, and is "a non-governmental and non-profit making international organisation with the basic aim of furthering aeronautical and astronautical activities worldwide." FAI, "About the FAI" *About FAI*, online: FAI <http://www.fai.org/about>. The "FAI activities include the establishment of rules for the control and certification of world aeronautical and astronautical records." FAI, "What FAI Does" *About FAI*, online: FAI <http://www.fai.org/about/2>.

[196] FAA, AST, "FAA Commercial Astronaut Wings Issue = 2" *Licensing Regulations & Regulatory Activity: Current Licenses*, online: FAA/AST <http://ast.faa.gov/lrra/current_licenses.cfm> (listing Michael Melvill and Brian Binnie, SpaceShipOne pilots, as the only recipients, so far, of commercial astronaut wings). Melvill got his astronaut wings for the first successful SpaceshipOne flight in July 2005 and Binnie received his for the X-Prize flight. FAA, "Commercial Human Space Flight" *FAA Fact Sheet* (29 Dec. 2005), online: FAA <http://www.faa.gov/news/fact_sheets/news_story.cfm?contentKey=3332>. The FAA/AST issues commercial astronaut wings "to pilots and flight crew on board an AST-licensed launch vehicle on a flight that exceeds 50 miles." See Patricia Grace Smith, "Presentation of FAA Commercial Astronaut Wings To SpaceShipOne Pilot Mike Melvill" (21 June 2004), online: FAA/AST <http://ast.faa.gov/aboutast/speeches/PGS_Melvill_wings_2004-06-21.pdf>.

[197] See *e.g.* Intelsat, "What Are the Different Kinds of Orbits?" *Satellite Basics*, online: Intelsat <http://www.intelsat.com/resources/satellitebasics.aspx>; NOAA, "Glossary" *Satellites and Orbits: An Introduction*, online: NOAA <http://eic.ipo.noaa.gov/IPOarchive/ED/k-12/IPO/unit01/satellites_and_orbits_glossary.doc> [*Satellites and Orbits*].

[198] See Intelsat, *supra* note 197.

[199] See *ibid.* But see NOAA, *Satellites and Orbits*, *supra* note 197 (providing a LEO altitude range of 100 km - 1,500 km).

approximate. In some places it reaches farther, in others not so far, and it is affected by the orbital movement of the Earth. Even if there were a fixed line between the atmosphere and outer space, a large number of space activities take place well within the Earth's atmosphere. From a scientific perspective it is clear that there is an overlapping area where 'space' and 'atmosphere' coexist.

B. The Separate Legal Regimes of Airspace and Outer Space

There is no legally recognized boundary-line between airspace and outer space, but the fact each is regulated by a distinctive international treaty regime suggests a point of separation must exist somewhere. The fundamental principles of international air law and international space law are diametrically opposed; those of air law based on the territorial sovereignty of States and those of space law prohibiting the exercise of State sovereignty and territorial claims.

1. Airspace: The Chicago Convention and the ICAO

Although aviation began only slightly more than 100 years ago, when the Wright Brothers successfully flew the first powered airplane,[200] it did not take long for the world to recognize the need for specialized laws to govern this new form of transportation.[201] The development of public international air law traces its roots back to the Paris International Air Navigation Conference, which took place in 1910.[202] Following the developments in aviation technology during World War I, the increasing acceptance of air transportation, and the realization that aviation was destined to be an international

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200 See *e.g.* Charles H. Gibbs-Smith, *Aviation: An Historical Survey From its Origins to the End of World War II* (London: Her Majesty's Stationary Office, 1970) at 94-104 (discussing the Wright Brothers invention of the powered airplane and its first successful flight in 1903).

201 See generally I. H. Ph. Diederiks-Verschoor, *An Introduction to Air Law*, 7th ed. (The Netherlands: Kluwer, 2001) at 2-5 (describing the origins of international air law).

202 See generally *ibid.* at 2 (describing the Conference as "[t]he first concerted attempt at codification on an international scale," but noting that because of political disagreements no "tangible results" were produced).

form of transportation,[203] an international air law convention was deemed essential.[204] The first public international air law treaty, the Paris Convention, was concluded in 1919.[205] Advances in technology and changes in the world political climate between 1919 and the end of World War II led States to recognize the need for a new international air law instrument. That instrument was the 1944 Chicago Convention on International Civil Aviation, which is the public international air law treaty regime that is still applicable today.[206]

Article 1 of the Chicago Convention provides "[t]he contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory."[207] As the use of the term "recognize" suggests, this rule did not originate with the Chicago Convention. Rather, it was carried over from the Paris Convention,[208] which itself was recognizing an existing principle of customary international law.[209]

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[203] See generally Gibbs-Smith, *supra* note 200 at 152-80 (generally discussing the historical development of aviation and describing the evolution of "practical powered flying" prior to WWI, the advances during WWI, and the first transatlantic flights following the war).

[204] See generally Diederiks-Verschoor, *supra* note 201 at 2 (noting that following the first scheduled international flights "it was considered necessary for existing regulations to be incorporated into a Convention").

[205] *Convention Relating to the Regulation of Aerial Navigation*, 13 October 1919, 11 L.N.T.S. 173 [*Paris Convention*].

[206] *Convention on International Civil Aviation*, 7 December 1944, 15 U.N.T.S.295, T.I.A.S. No. 1591 [*Chicago Convention*]. At the same time agreements were reached on air transit and air transport, which were annexed to the Chicago Convention. See *International Air Services Transit Agreement*, 7 December 1944, 84 U.N.T.S. 389, 59 Stat. 1963 [*Transit Agreement*]; *International Air Services Transport Agreement*, 7 December 1944, 171 U.N.T.S. 387, ICAO Doc. App. IV-2187 [*Transport Agreement*]. The Chicago Convention also created the ICAO, which is a UN specialized agency with the authority (derived from the Chicago Convention) to govern and promote the development of international civil aviation. *Chicago Convention*, *supra* note 206 at part II.

[207] *Chicago Convention*, *supra* note 206 at art. 1. See also Nicolas Mateesco Matte, *Aerospace Law* (Toronto: Carswell, 1969) at 16 (noting a great emphasis was placed "on the completeness and exclusivity of the sovereign rights, which made "it clear that transit and transport privileges . . . cannot be taken for granted in treaties, nor do they result in the development of a rule of customary international law," meaning that "any incursion [into foreign airspace] without the consent of the subjacent state constitutes a violation of national sovereignty and thus a violation of international law").

[208] *Convention Relating to the Regulation of Aerial Navigation*, 13 October 1919, 11 L.N.T.S. 173 [*Paris Convention*].

[209] See *e.g.* Diederiks-Verschoor, *supra* note 201 at 4 (noting that the principle of State sovereignty over territorial airspace dates back to Roman times). Because the concept of State sovereignty over airspace

It is important also to note that State sovereignty applies only to "territorial" airspace because this means a significant portion of the Earth's airspace, mainly that over the high seas, is not subject to the sovereignty of any State.[210] In effect this creates two types of airspace, territorial airspace and non-territorial airspace. While the Chicago Convention is applicable to civil aviation in both territorial airspace and over the high seas, the limitations placed on the freedom of use of territorial airspace due to State sovereignty are not present in the airspace over the high seas.[211]

Under public international law the high seas are considered to be *res communis*, meaning that they "may not be subjected to the sovereignty of any state . . . and states are bound to refrain from any acts which might adversely affect the use of the high seas by other states or their nationals."[212] Given that territorial airspace is found only above a State's "territory,"[213] and that the high seas are not subject to territorial claims, the airspace above the high seas cannot be claimed as territorial airspace. States are therefore precluded from exercising any sovereign control over the airspace above the high seas,[214]

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is one of longstanding customary international law, it is applicable regardless of the civil or State status of the aircraft in question, whereas the Chicago Convention itself applies only to civil aircraft. See *Chicago Convention*, *supra* note 206 at art. 3 (specifically excluding State aircraft, which include "[a]ircraft used in military, customs and police services," from the scope of the Convention). See also Bin Cheng, *Studies in International Space Law* (Oxford: Clarendon Press, 1997) at 4 (stating sovereignty over airspace is "declaratory of existing international law").

210 The Chicago Convention defines a State's "territory" as "the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such State." *Chicago Convention*, *supra* note 206 at art. 2.

211 See *Chicago Convention*, *supra* note 206 at art. 12 (stating "[o]ver the high seas, the rules in force shall be those established under this Convention").

212 Ian Brownlie, *Principles of Public International Law*, 6th ed. (New York: Oxford University Press, 2003) at 169.

213 *Chicago Convention*, *supra* note 206 at art. 1 (recognizing "that every State has complete and exclusive sovereignty over the *airspace above its territory*") [emphasis added].

214 States do, however, exercise sovereign control over the airspace above their territorial waters. *Chicago Convention*, *supra* note 206 at art. 2. Territorial waters are under the sovereign control of the costal State, although a right of innocent passage through the territorial waters, based in customary international law, is recognized. Brownlie, *supra* note 212 at 187. There is no corresponding right of innocent passage through the sovereign airspace above the territorial sea. See generally Diederiks-Verschoor, *supra* note 201 at 32 (noting that "in respect of the territorial waters . . . no right of innocent passage for aircraft exists like there is a right for ships in the same area"); Brownlie, *supra* note 212 at 115 (stating, with respect to air law, that "the law does not permit a right of innocent passage, even through airspace over the territorial sea").

although the concept of ADIZs does effectively allow States to exercise some extent of sovereignty over airspace adjacent to their territorial airspace.[215] Nonetheless, ADIZs aside, it can generally be said that over the high seas both airspace and outer space share the same *res communis* classification.[216]

While the principle of State sovereignty of territorial airspace is well-established in international law, and a violation of that airspace is unquestionably a violation of international law,[217] a definition of 'airspace' is lacking in the Chicago Convention and elsewhere.[218] The failure to define an upper limit to airspace could lead to confusion and conflict, such as in a case where one State is conducting activities in the airspace above the territory of another State. The first State may well believe its activities are being conducted in outer space, while the second State may find those activities to be a violation of its territorial airspace. While in most situations such an incident would be

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215 See *e.g. Security Control of Air Traffic*, 14 C.F.R. § 99.3 (2006) (defining an ADIZ as "an area of airspace over land or water in which the ready identification, location, and control of all aircraft (except for Department of Defense and law enforcement aircraft) is required in the interest of national security"); 14 C.F.R. §§ 99.43 – 99.49 (specifying the area included within the U.S. ADIZs). See also Cmdr. John Astley III and Lt. Col. Michael N. Schmitt, "The Law of the Sea and Naval Operations" (1997) 42 A.F. L. Rev. 119 at 137-38 (stating that "[s]ome States, including the US, have established air defense identification zones (ADIZ) in international airspace [which] . . . are permissible under international law only to the extent they constitute a condition of entry into national airspace . . . if it is merely passing through the ADIZ, the aircraft need not, as a matter of law, abide by the coastal State's conditions . . . however, most usually do").

The U.S. is only one of many States that have established ADIZs around their territorial airspace. The semi-widespread use of such zones, along with the acceptance of these zones by other States, may suggest that, to some extent, customary international law may condone subjecting international airspace to limited national control. This concept could have significance with respect to outer space because, if a boundary is ultimately fixed, it may open the possibility of States extending their control beyond that boundary into outer space and justifying it as a continuation of the ADIZ.

216 See generally Brownlie, *supra* note 212 at 169 (noting "outer space and celestial bodies have the same general [*res communis*] character" as the high seas). However, sharing the same classification does not mean outer space and airspace over the high seas share the same law. Airspace and outer space remain two distinct locales, each governed by separate public international law regimes.

217 See *e.g. ibid.* at 115-16 (stating that "[a]erial trespass may be met with appropriate measures of prevention, but does not *normally* justify instant attack with the object of destroy the trespasser") [emphasis added].

218 See generally *ibid.* at 256 (noting "[t]here is no provision on the precise boundary between outer space and airspace, or, more precisely, between the regime of *res communis* and the sovereignty of states over national territory").

dealt with through diplomatic channels, there exists a possibility that antagonistic regimes may employ more drastic measures (especially in a time of conflict).[219]

2. *Outer Space: The UN, COPUOS, and the Outer Space Treaties*

The space age officially began, in the midst of the Cold War, on 4 October 1957 when the Soviet Union successfully launched Sputnik 1 into orbit, followed less than a month later by Sputnik 2.[220] The recognition of outer space as a new legal, as well as scientific frontier, was not long in coming; on 14 November 1957 UNGA Resolution 1184 introduced a concept that would become one of the foundations of international space law – the use of outer space exclusively for peaceful purposes.[221] The following year the *ad hoc* Committee on the Peaceful Uses of Outer Space was established,[222] and the next year the COPUOS was officially established as a permanent body.[223] In the

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219 See *supra* note 217.

220 See generally Roger E. Bilstein & Frank Walter Anderson, *Orders Of Magnitude: A History Of The NACA and NASA, 1915-1990* (Washington DC: NASA, 1989) at 45 (discussing the launch of Sputnik 1 and Sputnik 2).

221 *Regulation, Limitation and Balanced Reduction of All Armed Forces and All Armaments; Conclusion of an International Convention (treaty) on the Reduction of Armaments and the Prohibition of Atomic, Hydrogen and Other Weapons of Mass Destruction*, GA Res. 1148(XII), UN GAOR, 1957, at sec. 1(f) (urging States to reach a disarmament agreement that, among other things, would provide for "[t]he joint study of an inspection system designed to ensure that the sending of objects through outer space shall be exclusively for peaceful and scientific purposes").

222 *Question of the Peaceful Use of Outer Space*, GA Res. 1348(XIII), UN GAOR [*Question of Peaceful Use*], 1958. This Resolution, the first to focus exclusively on outer space, recognized "the common interest of mankind in outer space" and continued the focus on the use of outer space for only peaceful purposes. *Ibid.* It also requested the ad hoc Committee report back to the UNGA about "[t]he nature of legal problems which may arise in the carrying out of programmes to explore outer space." *Ibid.*

223 *International Co-operation in the Peaceful Uses of Outer Space*, GA Res. 1472(XIV), UN GAOR, 1959. As was the case with the ad hoc Committee, the COPUOS was tasked with studying, among other things, "the nature of legal problems which may arise from the exploration of outer space." *Ibid.* Today the COPUOS, which consists of the Legal Subcommittee and the Scientific and Technical Subcommittee, continues to be the official UN body for space matters. The COPUOS submits annual reports to the UNGA, providing information on its work, and continues to consider legal issues relevant to outer space, though no new space law treaties have been concluded since 1979. See UNOOSA, "United Nations Committee on the Peaceful Uses of Outer Space," online: UNOOSA <http://www.unoosa.org/oosa/en/COPUOS/copuos.html> ["COPUOS"] (providing detailed information on the COPUOS).

subsequent years additional UNGA Resolutions were adopted,[224] including a Declaration of Legal Principles which stated, among other things, that international law was applicable to outer space and that "[o]uter space and celestial bodies are not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[225] These early UNGA Resolutions and the activities by the COPUOS set the groundwork for international space law as we know it today.

Today public international space law consists of five multilateral treaties.[226] The OST is the fundamental space law document, setting out the applicable regime and determining the legal status of outer space.[227] The OST, which was derived in large part from concepts contained in earlier UNGA Resolutions and findings of the COPUOS, makes it clear that outer space is legally distinguishable from airspace.

Article I of the OST provides that outer space "shall be the province of all mankind" and "shall be free for exploration and use by all States."[228] Article II of the OST further provides "[o]uter space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation,

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224 See *International Co-operation in the Peaceful Uses of Outer Space*, GA Res. 1721(XVI), UN GAOR, 1961; *International Co-operation in the Peaceful Uses of Outer Space*, GA Res. 1802(XVII), UN GAOR, 1962. These Resolutions contained no new legal concepts, rather just urged COPUOS to continue to work on the development of law for outer space.

225 *Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space*, GA Res. 1962(XVIII), UN GAOR, 1963.

226 See *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 27 January 1967, 610 U.N.T.S. 205, 6 I.L.M. 386 [*OST*]; *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, 22 April 1968, 672 U.N.T.S. 119, 7 I.L.M. 149 [*Rescue Agreement*]; *Convention on the International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 U.N.T.S. 187, 10 I.L.M. 965 [*Liability Convention*]; *Convention on Registration of Objects Launched into Outer Space*, 12 November 1974, 1023 U.N.T.S. 15, 14 I.L.M. 43 [*Registration Convention*]; *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, 18 December 1979, 1363 U.N.T.S. 3, 18 I.L.M. 1434 [*Moon Agreement*]. Although it entered into force in 1984, as of 1 January 2006 only 12 States were party to the Moon Agreement, none of which is a major space power.

227 The OST has been ratified by all major space powers and, as of 1 January 2006, has 98 ratifications and 27 signatures. See UNOOSA, "United Nations Treaties and Principles on Space Law," online: UNOOSA <http://www.unoosa.org/oosa/SpaceLaw/treaties.html> (listing the space treaties along with their respective ratification information).

228 *OST*, *supra* note 226 at art. I.

or by any other means."[229] The significance of these provisions is clear; territorial airspace does not continue indefinitely upward. At some point territorial airspace must give way to outer space, where no State may claim sovereign rights or territory.

The problem arises because, just as the Chicago Convention failed to define 'airspace,' neither the OST, nor any of the subsequent space treaties, defines 'outer space.'[230] At the time the OST was drafted the definition of outer space was not considered a priority issue, at least in part because of the anticipated political difficulty in getting States to agree to a particular boundary.[231] Since that time, the issue has been constantly revisited, but never resolved. As a result the only certainty is that outer space and airspace are indeed separate realms, subject to separate legal regimes.[232] Where territorial airspace, and therefore State sovereignty, ends remains an open question, at least based on the law contained in international air and space law treaties.[233]

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229 *OST*, *supra* note 226 at art. II.

230 The failure to define/delimit has long been recognized as a problem with the OST. In 1968 Matte wrote, "[t]he inadequacy of the Space Treaty begins with Article I . . . new realms, such as outer space, the moon and other celestial bodies, are enumerated, without any effort being made to define the terms or at least to determine their boundaries." Matte, *supra* note 207 at 290. Matte further noted that an answer to the definition "question is very important, because of the present double status, of sovereignty in the air and freedom beyond." *Ibid.* at 291.

231 See *e.g.* Cheng, *supra* note 209 at 101 (quoting the report of the *ad hoc* Committee on the Peaceful Uses of Outer Space as stating, in 1959, that "the problem of 'determining where outer space begins'" was not "'susceptible of priority treatment,' inasmuch as States may find it hard to achieve a general agreement").

232 See *e.g.* Matte, *supra* note 207 at 20 (stating that "the exploration of space takes place in two spheres, each with a different legal status. The take-off and landing of space vehicles require the use of the 'territorial' air space . . . while most of the operations themselves take place in the free outer space"); Cheng, *supra* note 209 at 227 (noting the OST "establishes a special regime for outer space, fundamentally different from national airspace which is subject to the complete and exclusive sovereignty of the State).

233 See generally Cheng *supra* note 209 at 33 (noting "any frontier which is not unequivocal is bound to be a source of controversy. The most urgent task in space law is, therefore, to secure a general agreement among States fixing the precise upper limit of national sovereignty.").

C. The Delimitation of Outer Space: The Ongoing Debate Within the COPUOS

The COPUOS has long been tasked with resolving the question of exactly where airspace ends and outer space begins.[234] Its failure to answer that question is not due to a lack of adequate consideration; the matter has been on the COPUOS agenda for over forty years, discussed and reported on each year.[235] Despite this seemingly unwavering attempt to find a definition, the COPUOS has made little in the way of progress. As with any forum where members are States (with their corresponding and often opposed national interests), politics, rather than practicality or logic, is often the driving force behind discussions and the thing standing in the way of decision.[236] The difficulty of reaching a decision within the COPUOS is further compounded by the fact that all decisions must be made on the basis of consensus.[237] However, despite the lack of

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234 The COPUOS inherited this issue from its predecessor, the *ad hoc* Committee on the Peaceful Uses of Outer Space. See UN GAOR, *Question of Peaceful Use*, *supra* note 222 at sec. 1(d) (requesting the ad hoc Committee on the Peaceful Uses of Outer Space report on "[t]he nature of legal problems which may arise in the carrying out of programmes to explore outer space"). Before the OST was even opened for signature and ratification, the COPUOS was officially tasked with considering the specific question of the outer space boundary. See *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, GA Res. 2222(XXI), UN GAOR, 1966 at 13 (requesting COPUOS study "questions relative to the definition of outer space").

235 The 2006 report of the Legal Subcommittee indicates that once again the question of the definition of outer space will remain on the agenda. See *Report of the Legal Subcommittee on its Forty-Fifth Session*, UN GAOR, 2006 UN Doc. A/AC.105/871, at 3 [*LS 45th Session Report*]. Discussions on the boundary issue continued in the 2006 meetings of the Legal Subcommittee and "[t]he view was expressed that scientific and technological progress, the commercialization of outer space, emerging legal questions and the increasing use of outer space in general had made it necessary for the Legal Subcommittee to consider the question of the definition and delimitation of outer space." *Ibid.* at 15. See also *Report of the Legal Subcommittee on the Work of its Thirty-Fourth Session*, UN GAOR, 1995 UN Doc. A/AC.105/607, at 8 [*LS 34th Session Report*] (reporting that "[t]he Subcommittee recalled that the item relating to the definition and delimitation of outer space had been on the agenda of the Legal Subcommittee since 1967").

236 See *e.g.* Nathan C. Goldman, "Space Law" in Eligar Sadeh, ed., *Space Politics and Policy: An Evolutionary Perspective* (The Netherlands: Kluwer, 2002) 163 at 163, 180 (noting that historically "the development of the international law of outer space is inextricably linked to . . . international politics and policy" and that, looking ahead, "political and market forces set the stage for the future development of space policy and law").

237 See generally UNOOSA, "COPUOS," *supra* note 223 (stating the COPUOS and both its subcommittees work "on the basis of consensus"); Cheng, *supra* note 209 at 164 (explaining "[c]onsensus is of course a form of unanimity . . . [w]hat it does mean is that no decision will be taken against the strong objection of any member; in particular no decision will be taken without the

decision, the ongoing debate within the COPUOS has shown that States are generally divided into two camps on the boundary question – the functionalists and the spatialists.[238]

1. The Functionalists

According to the functionalist theory a boundary is not necessary because the location of a particular activity (airspace or outer space) is irrelevant.[239] Instead functionalists, represented most notably by the U.S., argue it should be the use made of the object that determines whether air law or space law is applicable.[240] Functionalists point out that any boundary line drawn would necessarily have to be arbitrary[241] and "the

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concurrence of any member that really matters"). Cheng further notes that the "procedure of consensus requires a great deal of behind-the-scenes consultation, especially among the parties 'directly concerned' . . . the most critical part of the negotiations was always carried out behind the scenes . . . the situation could get to such a stage that, notwithstanding pleas from the Rapporteur and the Chairman, no one would discuss the really critical issues faced by the [legal] Sub-Committee in open session." *Ibid.* at 165.

238 See generally *Historical Summary on the Consideration of the Question on the Definition and Delimitation of Outer Space*, UN GAOR, 2002 UN Doc. A/AC.105/769 [*COPUOS Historical Summary*] (providing a report from the Secretariat, prepared at the request of the Legal Subcommittee, summarizing the history of the COPUOS' consideration of the boundary issue, including the views of various States).

239 See *e.g.* Cheng, *supra* note 209 at 445 (explaining "[t]he essence of the functionalists' argument is that the locus of an act need be of no moment to its legality or illegality, which can be determined solely by reference to its nature"). Some functionalists believe that a fixed air/space boundary will be required in the future, but do not believe it is currently necessary and therefore the location of such a boundary should not yet be determined. See *ibid.* at 446-47 (referring to this group as "wait-and-see functionalists" and commenting that this attitude is akin to "letting sleeping dogs lie and . . . even letting them have one free bite when they wake up").

240 See *e.g. ibid.* at 397 (stating that the U.S. is one of the States which supports the functional approach); *ibid.* at 427 (noting that functionalists "widen[ed] the scope of their terms of reference to include the definition of not only the function of activities, but also the functions of vehicles"). See also Wybo P. Heere, "Problems of Jurisdiction in Air and Outer Space" (1999) 24 Air & Space L. 70 at 78 (describing the functionalist theory as "that which is designed and built for use in outer space, is a spacecraft. The use of spacecraft determines the use of space law.")

241 A boundary would necessarily be arbitrary because there is no precise, scientific divide between airspace and outer space. See *e.g.* Matte, *supra* note 207 at 23 (discussing the problems with a scientific definition of the air/space boundary and noting a "scientific definition of the air space leads to insurmountable difficulties in the establishment of its upper limits"); Cheng, *supra* note 209 at 600 (noting that functionalists often argue "that geophysicists are unable, from the scientific point of view, to point to any specific line separating airspace from outer space").

lawfulness or unlawfulness of space activities should be determined solely by the nature of the activity or of the vehicle."[242]

To take an example, from a purely functionalist approach the Shuttle would be regulated entirely by space law, regardless of where it was located.[243] The Shuttle is intended to go to space and undertake various space missions (the nature of its activity is space-based) and the vehicle itself is designed to go to space, not for any other purpose (the nature of the vehicle is space-based). Functionalists would argue that because the Shuttle is a space vehicle, undertaking space activities, it should at all times be regulated by space law. This would hold true regardless of the position of the Shuttle, whether it be in territorial airspace, airspace above the high seas, or in outer space. This analysis would be applicable to other RLV technology, so long as the nature of the activity and/or the vehicle was space-based. If, however, a spaceplane were to make a flight through space for the purpose of traveling from one terrestrial point to another, the functionalist analysis would change. In that case, the nature of the activity and the vehicle would likely be equated with that of air transport because functionally the spaceplane was performing the task of an aircraft, meaning air law would apply to the entirety of the flight, even that portion occurring in outer space. Therefore, under the functionalist approach, the same craft could be subject to separate laws (for separate flights), depending on the particular purpose of a given flight.

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[242] Cheng, *supra* note 209 at 600. In other words, there is no need for a boundary because "all one has to do is to regulate space activities.". *Ibid.* at 645.

[243] In fact, under U.S. law, the Shuttle is classified as a spacecraft. See *National Aeronautics and Space Act of 1957, as amended*, 42 U.S.C. §§ 2451 et seq. (2006) at § 2452(1); *Commercial Space Transportation, Suborbital Rocket Launch, Notice and Request for Comments*, 68 Fed. Reg. 26373 (2003) at 26276 [2003 Notice and Request] (noting that "the Space Shuttle has wings but is not regarded as an aircraft").

However, because the Shuttle is government operated, it is not subject to the same licensing regulations as private spacecraft. Interestingly, if the Shuttle were privately operated, it would likely be required to obtain both a launch license and a FAA airworthiness certification, which demonstrates that even in the U.S., the biggest proponent of the functionalist approach, in practice an object that is functionally a spacecraft is still subject to both aviation and space launch regulations. See 2003 Notice and Request, *supra* note 243 at 26274-76 (stating that the Shuttle is not "subject to licensing because its operation is deemed to be by and for the Government and therefore exempt from the CSLA" but further stating that for hybrid vehicles "which employ aviation characteristics" both FAA airworthiness certification and a launch license are required).

In the case of a system such as the still-theoretical space elevator, functionalists would probably advocate the use of space law. The purpose of the space elevator would be the transfer of materials and/or personnel to outer space (essentially the same thing the Shuttle does), therefore functionally a space activity. However, the space elevator presents interesting complications because it does not fit any existing definition of 'aircraft' and it would not seem to fall within the definition of 'space object' because it is not 'launched' into space.[244] Additionally, when looking at the space elevator as a whole, part of it will permanently be in outer space, part will be permanently in airspace, and part will be anchored to the earth (or to a sea-based platform), meaning it is simultaneously in two or three realms, all governed by different laws. Consequently, although functionalists may want to regulate the space elevator under space law, it is not necessarily clear which portions of international space law would be applicable to a space elevator.[245]

2. *The Spatialists*

Spatialists, reflecting the opinion of the majority of States,[246] believe it is necessary to establish a boundary between airspace and outer space as soon as possible, which will once and for all settle the question of where territorial airspace ends and outer space begins.[247] However, although agreeing that there should be a boundary, there is significant disagreement among spatialists as to where the boundary should be located,

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[244] While the operation of a space elevator might be considered a space activity for purposes of OST Article VI, it is not clear that the liability provision, Article VII, would apply because it speaks in terms of objects launched into outer space. Because the Liability Convention is an elaboration of Article VII, it too speaks of liability for objects that were launched into outer space. While some "component parts" of a space elevator may be launched into space, it is not clear whether that fact would make the entire space elevator a space object for Liability Convention purposes.

[245] The functionalist approach would also face additional complications if it were possible for the space elevator to make 'stops' in airspace, such that it could be used to deliver cargo to both airspace and outer space during the same ascent.

[246] See *e.g.* Cheng, supra note 209 at 397 (stating that "there has been increasing support among States for the [spatialist] views," including support by the U.S.S.R., which, at the 18th session of the COPUOS Legal Subcommittee, "proposed first the recognition of the region above 100 (110) kilometres altitude from the sea level of the earth as outer space, and secondly, the establishment by treaty of a boundary between airspace and outer space at an altitude not higher than 100 (110) kilometres above sea level").

[247] See *e.g. ibid.* at 426, 645.

what it should be based on, and even how many boundary lines must be drawn.[248] The numerous boundary line proposals put forth by spatialists, both inside and outside the COPUOS, demonstrates the source of difficulty in arriving at a delimitation point between airspace and outer space is attributable to more than simply the opposing spatialist and functionalist factions. Included among the many spatialist proposals and theories for a boundary line are the following: the atmosphere or its various layers,[249] the edge of gravitational effect,[250] the rotational theory,[251] the von Karman line (aerodynamic theory),[252] the lowest perigee of satellites (either actual or theoretical),[253] a biologically-

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248 See *e.g. ibid.* at 426 (discussing the disagreement among spatialists as to the location of the boundary and various proposals for the boundary location).

249 See *e.g.* Goedhart, *supra* note 180 at 31-34 (defining this proposal as one in which "the legal boundary of the atmosphere would then coincide with the natural boundary of the atmosphere," but noting that it would not solve the problem because "[w]ithin the ranks of scientists there is no unanimous agreement on the quality and quantity of the atmosphere"); Matte, *supra* note 207 at 21-23 (discussing the problems with using the atmosphere as a boundary). See also Chapter II.A, above (discussing the atmosphere from a scientific perspective).

250 See *e.g.* Goedhart, *supra* note 180 at 40 (noting that this would be the point where the Sun's gravitational pull becomes stronger than that of the Earth, at a distance of approximately 1.5 million km); Matte, *supra* note 207 at 31 (stating that "Joseph Kroell expounded the theory relying on the earth's gravity in 1953 by suggesting that the boundary be set 'where the mathematical value of the field of the earth's gravitation is nill'"). This theory would not be very practical and would contradict existing law given that all human activities in 'space' have taken place well within 1.5 million km of Earth and that the Moon, at a distance of 384,400 km from Earth, is established as being in outer space by Article I of the OST which refers to outer space as "*including* the moon *and other* celestial bodies" [emphasis added]. See NASA, "Earth's Moon" *Solar System Exploration*: *Planets*, online: NASA <http://solarsystem.nasa.gov/planets/profile.cfm?Object=Moon> (providing data on the moon, including its distance from the Earth).

251 See *e.g.* Goedhart, *supra* note 180 at 43-44 (explaining that according to this theory airspace ends "at such a height that the effect of the Earth's spinning around its axis is no longer perceptible," but noting the problem is that the atmosphere and the Earth do not rotate simultaneously).

252 See *e.g. ibid.* at 61 (stating that according to the von Karman theory "[t]he extreme boundary of air flight is supposed to be at an estimated altitude of 275,000 ft (i.e. rounded up to 83 km) above the Earth and to be identical with the lower limit of space flight"). See also Matte, *supra* note 207 at 30-31 (discussing the von Karman line and aerodynamic theory, but noting that evolving technologies would change a boundary based on such criteria).

253 See *e.g.* Goedhart, *supra* note 180 at 47-50 (discussing the lowest perigee theory); Matte *supra* note 207 at 31-32 (discussing the lowest perigee theory). This theory is also the general basis for the argument that a boundary has been established by customary international law. See Chapter II.D.2, above, for a discussion of a possible customary boundary.

based boundary,[254] the effective control theory,[255] a zoning approach,[256] an arbitrary height, the 100 km mark,[257] and others.

3. *Working Group on the Definition and Delimitation of Outer Space*

One of the groups within the COPUOS Legal Subcommittee is the Working Group on the Definition and Delimitation of Outer Space (WGDD).[258] The purpose of the WGDD is to examine the delimitation question in order to assist the COPUOS in its consideration of the matter.[259] The WGDD is not any closer to coming to a conclusion

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254 See *e.g.* Godehart, *supra* note 180 at 35 (explaining "[i]n this theory, the atmosphere stretches as far as human life is sustainable without all sorts of technical devices," but noting that "[f]rom the standpoint of physiology, outer space and air space are already identical at an altitude between 4 km (*e.g.* at the highest peaks of the Alps) and 6 km (*e.g.* at the highest peaks of the Andes)").

255 See *e.g. ibid* at 99 (explaining that according to this theory "[t]he region where an underlying State is able to assert its effective power, may hence be regarded as State territory"); Matte *supra* note 207 at 32-34 (discussing the effective control theory and noting that such a boundary depends on technology and that all States would not be "at the same degree of technical development, and as most probably they never will be, the question arises as to how some of them will be able to control the space above their territory as effectively as others"). Clearly if effective control were determined on a State by State basis, the result would be different levels of effective control, which would create a splintered boundary that would not be workable.

256 See *e.g.* Goedhart, *supra* note 180 at 65-74 (explaining that according to this theory airspace would be divided into three zones, similar to the way the ocean is divided by maritime law, such that there would be territorial airspace, a "contiguous space" with a right of innocent passage similar to the territorial seas, and outer space); Matte, *supra* note 207 at 37-44 (discussing zone theories).

257 This is basically an arbitrary height, though it is often the location where a boundary based on customary international law is placed. See Goldman, *supra* note 236 at 165. The U.S.S.R. also officially proposed a boundary be located at this height in the COPUOS in 1979. See Cheng, *supra* note 201 at 427-28, 452-55 (discussing and analyzing the U.S.S.R. proposal, the text of which can be found in UN Doc. A/AC.105/C.2/L.121).

258 Reports of the WGDD can generally be found annexed to the annual reports of the Legal Subcommittee. See *e.g. LS 45th Session Report*, *supra* note 235 at 30 (containing a copy of the latest report of the WGDD).

259 See generally *Report of the Legal Subcommittee on its Fortieth Session*, UN GAOR, 2001 UN Doc. A/AC.105/763, at 19 [*LS 40th Session Report*] (noting the WGDD "would convene to consider only matters relating to the definition and delimitation of outer space"). Prior to this session the WGDD also included matters related to the GEO in its sessions, but the COPUOS had endorsed a suggestion the previous year to limit the discussion to boundary matters. *Ibid.*

on the subject than the COPUOS Legal Subcommittee, showing the same divide on opinion that is present in the Legal Subcommittee.[260]

In 1995 the WGDD finalized the text of a questionnaire on aerospace objects, which it had been working on for several years.[261] The questionnaire was distributed to UN member States in order to get their views on "various issues relating to aerospace objects" for the purpose of helping "provide a basis for the Legal Subcommittee to decide how it might continue its consideration of" the definition/delimitation question.[262] Essentially, the question of aerospace objects provides a concrete example of problems that may be created by the lack of a boundary, therefore allowing the WGDD and the COPUOS to look at the delimitation question in the context of an emerging technology that could be affected by (or affect) the ultimate answer to the boundary question.[263]

Replies to the questionnaire have been received from various States since 1996, becoming part of the official records.[264] The WGDD makes use of these replies in its annual sessions, although, as of yet, the questionnaire does not seem to have helped in

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260 See generally *LS 45th Session Report*, *supra* note 235 at 32 (listing views of various delegations on the boundary matter at the most recent session). Similar views can be found in the reports available from prior years.

261 *LS 34th Session Report*, *supra* note 235 at 8.

262 *Ibid.* at 8-9. The idea of a questionnaire on this topic was first proposed by the Russian Federation delegation in 1992, with the explanation "that there was currently an impasse in the Working Group between States which believed that the delimitation of airspace and outer space was necessary, and States which believed it was not . . . the [draft questionnaire] was submitted as a starting-point for a discussion which might break this impasse." *Report of the Legal Subcommittee on the Work of its Thirty-First Session*, UN GAOR, 1992 UN Doc. A/AC.105/514 at 20 [*LS 31st Session Report*].

263 The definition of "aerospace object" is not included in the questionnaire. However, the first question asks whether "an aerospace object be defined as an object which is capable both of travelling through outer space and of using its aerodynamic properties to remain in airspace for a certain period of time?" See UNOOSA, "Questionnaire on Possible Legal Issues with Regard to Aerospace Objects," online: UNOOSA <http://www.unoosa.org/pdf/misc/aero/questE.pdf> (providing a copy of the final version of the questionnaire).

264 See *Questionnaire on Possible Legal Issues with Regard to Aerospace Objects: Replies From Member States*, UN GAOR, 1996 UN Doc. A/AC.105/635. Responses received in subsequent years can be found in the Addenda to UN Doc. A/AC.105/635. A compilation of all responses received as of 26 January 2005 is available online from UNOOSA. See UNOOSA, "Compilation of Replies Received from Member States to the Questionnaire on Possible Legal Issues with Regard to Aerospace Objects," online: UNOOSA <http://www.unoosa.org/docs/misc/aero/aero_compE.doc>.

breaking the impasse, as the WGDD seems no closer to a resolution of the matter and the split between the functionalists and spatialists remains.[265]

D. Outside the COPUOS: Other Sources of an Air/Space Boundary Determination

Although the COPUOS appears to have sole authority over outer space matters, there are, in fact, several other sources which may ultimately lead to the establishment of a defined legal boundary between airspace and outer space.

1. Conference on Disarmament

The UN Conference on Disarmament (UNCD) was "established in 1979 as the single multilateral disarmament negotiating forum of the international community."[266] As part of its agenda, the UNCD routinely considers disarmament issues related to outer space, such as preventing an arms race in space[267] and "greater transparency and confidence-building measures in the context of outer space activities."[268] The ultimate purpose of these discussions within the UNCD is to create a treaty addressing the

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265 See also Nandasiri Jasentuliyana, *International Space Law and the United Nations* (Netherlands: Kluwer, 1999) at 52-53 (noting that the questionnaire received only a low number of responses, which limited its effectiveness in stimulating further debate on the topic).

266 UNOG, "Conference on Disarmament" *Disarmament*, online: UNOG <http://www.unog.ch/80256EE600585943/(httpPages)/2D415EE45C5FAE07C1257180005232B?OpenDocument>.

267 See generally UNOG, "Conference on Disarmament Continues to Debate on the Prevention of an Arms Race in Outer Space" *News & Media* (15 June 2006), online: UNOG: <http://www.unog.ch/80256EDD006B9C2E/(httpNewsByYear_en)/66B24872AF57B784C125718E00354775?OpenDocument> (reporting on the ongoing discussions in the UNCD).

268 See generally UNOG, "Conference on Disarmament Debates Transparency and Confidence-Building Measures in Outer Space" *News & Media* (13 June 2006), online: UNOG: <http://www.unog.ch/80256EDD006B9C2E/(httpNewsByYear_en)/52E39130188AA029C125718C00327715?OpenDocument> (reporting "there was consensus on support for greater transparency and confidence-building measures in the context of outer space activities"). See also Stephen E. Doyle, *Civil Space Systems: Implications for International Security* (Aldershot, GB: Dartmouth, 1994 for UN Institute for Disarmament Research) at 175 (noting "discussions and proposals in the Conference on Disarmament have often addressed outer space issues, including suggestions to modify existing space treaties to: strengthen their military proscriptions, add new military provisions to enhance security, and establish possible new institutional structures to strengthen the maintenance of peace").

"prevention of the placement of weapons in outer space, and the threat or use of force against outer space objects."[269]

The ongoing discussions in the UNCD are of significance to the air/space boundary issue because it is unlikely an arms control treaty would be concluded without defining the precise scope of the territory covered by the treaty.[270] Given the sensitive nature of military matters and the need for a treaty in this area to be unambiguous, defining the air/space boundary would seem imperative.[271] Without such a definition, there is 'wiggle room' which would allow States to argue, for example, that weapons systems were actually placed in their own territorial airspace.[272]

The COPUOS has been arguing in circles on the boundary issue for over forty years, with progress seemingly permanently stalled, at least in part, by those States that assert there is no need for a boundary. The UNCD, however, has greater incentive to come to a conclusion on the issue because in its realm there *is* a need for a boundary; without a boundary much of the effectiveness of any treaty would be largely undercut.[273]

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269 UNOG, "Conference on Disarmament Holds Discussion on Importance of Preventing an Arms Race in Outer Space" *News & Media* (8 June 2006), online: UNOG: <http://www.unog.ch/80256EDD006B9C2E/(httpNewsByYear_en)/229A63CC973D95E1C1257187002D3121?OpenDocument> (noting also that "[t]here was widespread support among delegations which took the floor for the Conference to start negotiating a treaty on prevention of an arms race in outer space").

270 See generally Bhupendra Jasani, "Introduction" in Bhupendra Jasani, ed. *Peaceful and Non-Peaceful Uses of Space: Problems of Definition for the Prevention of an Arms Race* (NY: Taylor & Francis, 1991 for UN Institute for Disarmament Research) 1 at 16 (stating that "[i]in any discussion on the prevention of an arms race in outer space, the definition of a space weapon is critical, which in turn makes it essential to define the boundary between air and outer space").

271 *Ibid.*

272 See generally Jasentuliyana, *supra* note 265 at 76 (noting "it is felt that loopholes or uncertainties . . . in the current space law require the further elaboration of agreement in this [disarmament] field").

273 See also *A Gap Analysis Of Existing International Constraints On Weapons And Activities Applicable To The Prevention Of An Arms Race In Outer Space Agenda Item Of The Conference On Disarmament* (Canada Working Paper), UNCDOR (14 June 2006) UN Doc. CD/1784 (providing "an analysis of the various possible weapon-to-target engagement scenarios"). The scenarios identified in the Canadian working paper are described in terms of the location (earth-based and/or outer space-based) and function of the weapons systems (*i.e.* where the target is), which would suggest the need to carefully define where the line between an earth-based and space-based weapon is to be drawn, especially since the weapons and/or targets do not have to be physically on the ground to be considered earth-based. *Ibid.* See also *supra* note 270 and accompanying text.

Given this incentive, and the fact that there is near consensus within the UNCD that a treaty should be concluded,[274] it is possible that the UNCD, rather than the COPUOS, will be the source of the first public international law defining the air/space boundary.

2. *Customary International Law*

Customary international law is one of the sources of law that may be considered by the ICJ in deciding its cases.[275] It is important that the custom be "accepted as law," rather than simply a State practice.[276] The difference between practice and acceptance as law is based on whether the practice is seen as merely a general practice (perhaps similar to a tradition) or as a legal obligation.[277] There also must be "substantial uniformity,"[278] consistency and generality in the practice.[279] In determining whether the practice is seen as law, or *opinio juris*, the ICJ has taken two approaches, one requiring "positive evidence of the recognition of the validity of the rules in question in the practice of states," and the other assuming "the existence of an *opinio juris* based on evidence of a

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[274] But see Detlev Wolter, *Common Security in Outer Space and International Law* (Geneva: UN Institute for Disarmament Research, 2006) at 59 (noting "[t]he main problem with the approach of the CD since 1990 has been the need to agree annually to a 'comprehensive and balanced work programme', which, due to continuing obstructive linkage among the issues, has resulted in a total blockage of negotiations on the substance"). The U.S. is currently the only State blocking substantive negotiations. *Ibid.* at 74 (noting "[t]he statements of the delegations to the CD leave little doubt that with the exception of the United States, all states take the position that concrete multilateral negotiations on the prevention of an arms race in outer space should start without delay").

[275] *Statute of the International Court of Justice*, art. 38 (listing "international custom, as evidence of a general practice accepted as law" as one of the sources the ICJ may use to decide a case).

[276] *Ibid.*

[277] See generally Brownlie, *supra* note 212 at 8 (stating that a finding that the practice is obligatory is a "necessary ingredient" in finding it to be custom and noting "[t]he sense of legal obligation, as opposed to motives of courtesy, fairness, or morality, is real enough, and the practice of states recognizes a distinction between obligation and usage").

[278] *Ibid.* at 7. There is no requirement for complete uniformity. *Ibid.*

[279] *Ibid.* (noting that generality "is an aspect that complements that of consistency"). Generality refers to the practice being followed by States in general, though there is no requirement that the practice actually be universal. *Ibid.* Consistency refers to the practice being followed regularly, as a matter of course. *Ibid.* at 7-8.

general practice, or a consensus in the literature, or previous determinations of the Court other international tribunals."[280]

The question of whether a boundary between airspace and outer space exists in customary international law has never been tested before the ICJ or any other international tribunal. However, there is much support for the proposition that such a customary boundary does exist, primarily based on the fact that since the beginning of the space age satellites have been orbiting the Earth at certain altitudes and no State has ever objected to a satellite passing over its territory.[281]

Given the number of satellites in orbit, most every State has undoubtedly had a satellite cross its territory, but not a single State has ever objected.[282] It seems unlikely that no State has ever *wanted* to complain; after all, satellites can be used for remote sensing and could possibly have military purposes.[283] Given the fact that all States do not have satellites of their own (especially true at the beginning of the space age) this lack of complaint is even more remarkable because it is not a mutually beneficial situation; some States suffer satellite overflight of their territory, but do not themselves have such

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280 *Ibid.* at 8.

281 See generally *ibid.* at 256 (noting "[t]here may be a customary rule that satellites in orbit cannot be interfered with unless interference is justified in terms of the law concerning individual or collective self-defense"). Such self-defense would have noting to do with State sovereignty, but rather would be based on the OST which makes the UN Charter and international law applicable in outer space. *OST*, *supra* note 226 at art. III. The UN Charter specifically allows for "the inherent right of individual or collective self-defence if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security." *Charter of the United Nations*, art. 51. See also Cheng, *supra* note 209 at 394 (stating it is "possible to conclude that outer space under general international law would at least begin from the lowest point reached by an artificial satellite, in other words, the lowest perigee ever achieved").

282 See generally Cheng, *supra* note 209 at 601 (noting that "[i]n the absence of any successful protest *by any State that any of the artificial earth satellites so far launched into earth orbit has actually violated its national space or airspace sovereignty*, and in the light of express acknowledgements by some States that all existing artificial earth satellites were orbiting in outer space, the conclusion must be that there exists already a rule of general international law recognizing the lowest perigee of any existing or past artificial earth satellites as marking the beginning of outer space") [footnote emphasis added].

283 See generally Peter L. Hays, "Space Law" in Eligar Sadeh, ed., *Space Politics and Policy: An Evolutionary Perspective* (The Netherlands: Kluwer, 2002) 335-369 (providing a discussion of the military applications of space technologies, including remote sensing, as well as a discussion on various policy and political considerations related to the military use of space).

technology.[284] Conversely, States have complained (or taken more drastic measures) about high altitude aircraft violating their sovereign airspace, showing a recognition that sovereign rights were applicable at such altitudes.[285]

The lack of complaint about satellite overflight could certainly be taken as evidence of State recognition of a legal obligation to allow the satellite overflights, based on the satellites being in outer space (beyond the reach of State sovereign control over territorial airspace).[286] The requirements of universality, consistency, and generality seem to be met. Satellites have consistently been overflying the territory of all States for over forty years. All States were arguably affected by these satellite activities; any State could have complained (or taken action against such satellites) if it believed a violation of its sovereign territorial airspace was occurring. Not even one State has ever complained. Consequently, it seems likely that under customary international law the maximum altitude of territorial airspace is equivalent to the lowest perigee of satellites, as no State has ever tried to assert its sovereignty over its territorial airspace at that altitude and prevent the overflight of a satellite.[287]

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[284] Whereas it could be argued that the U.S. and U.S.S.R., the two longtime space superpowers, had incentive during the Cold War not to complain because each was receiving the advantage of overflying the territory of the other with its satellites.

[285] See *e.g.* National Archives and Records Administration, "The U-2 Spy Plane Incident" *Eisenhower Archives*, online: National Archives and Records Administration <http://www.eisenhower.archives.gov/dl/U2Incident/u2documents.html> (providing information on the 1 May 1960 U.S.S.R. shoot-down of a U.S. high altitude U-2 spy plane over U.S.S.R. territory, including links to numerous official documents of the era related to the incident); "Soviets Charge U.S. Aligned 747 With Satellite, Aircraft" *Aviation Week & Space Technology* (26 September 1983) 42 (reporting on the U.S.S.R.'s allegations that it shot down the civilian plane KAL 007 when it violated U.S.S.R. airspace because the plane was actually a U.S. spy plane); Nazila Fathi, "Iran Says Pilotless U.S. Planes Are Spying on Nuclear Sites" *New York Times* (17 February 2005) A16 (reporting Iran alleged "American pilotless spy planes had been seen over its nuclear sites, and it threatened to shoot them down if they came within range").

[286] See generally Goldman, *supra* note 236 at 165 (noting that "[w]hen Sputnik orbited over many national borders, no state complained or claimed an invasion of sovereignty").

[287] But see Cheng, *supra* note 209 at 455-56 (discussing the 1976 Bogota Declaration, in which eight equatorial States, "taking advantage of the fact that there is at present no clear-cut delimitation of outer space," claimed "the respective sectors of the geostationary orbit above their territory," arguing that the GEO was not part of outer space "'because its existence depends exclusively on its relation to gravitational phenomena generated by the earth'"). See also Jasentuliyana, *supra* note 265 at 152-53 (noting that the claims made in the Bogota Declaration "were rejected by the developed countries and

3. *National Legislation*

The increase in commercial space activity has prompted many States to enact domestic legislation dealing with outer space.[288] Domestic legislation must compliment, and not contradict, obligations found in the international space treaties to which the State is a party, and generally must comport with any customary international law that has developed with respect to outer space. Because the outer space treaties have failed to define the boundary between airspace and outer space, some States are taking it upon themselves to do so in their national legislation.

The Australian Space Activities Act of 1998 (1998 Act)[289] does not explicitly define the term "outer space," but it effectively places the lower limit of outer space at 100 km by including that distance in the definitions of "launch," "space object," "launch vehicle," and "payload."[290] According to the 1998 Act, to "*launch* a space object means launch the object into an area beyond the distance of 100 km above mean sea level, or attempt to do so" and "*space object* means a thing consisting of: (a) a launch vehicle; and (b) a payload (if any) that the launch vehicle is to carry into or back from an area beyond the distance of 100 km above mean sea level or any part of such a thing."[291] By incorporating the 100 km distance into its domestic space legislation, Australia has ensured that, at least with respect to domestic space activities, no confusion will arise as to whether air or space law is applicable in a given situation.[292]

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did not receive much support from other developing countries . . . [l]ack of support from other countries has led the equatorial countries to moderate their views on this matter, and most equatorial countries have moved away from the position stated in the Declaration").

288 See generally UNOOSA, "National Space Law Database" *Space Law*, online: UNOOSA <http://www.unoosa.org/oosa/en/SpaceLaw/national/index.html> ["National Space Law Database"] (providing links to the text of the domestic space law of various States).

289 *Space Activities Act 1998* (Cth.) [*1998 Act*].

290 *Ibid.* at s. 8. The references to the 100 km mark were actually added to the 1998 Act in 2002 by the Space Activities Amendment Act. See *Space Activities Amendment Act 2002* (Cth.) s. 2-4.

291 *1998 Act*, *supra* note 289 at s. 8. The 1998 Act also provides that "*launch vehicle* means a vehicle that can carry a payload into or back from an area beyond the distance of 100 km above mean sea level." *Ibid.*

292 See generally Peter van Fenema, "Suborbital Flights and ICAO" (Nov. 2005) 30 Air & Space L. 396 at 398 (noting that Australia added the 100 km mark to definitions in the 1998 Act because "the lack of a

South Africa has not provided as precise a definition of outer space as Australia, but it has defined outer space in its domestic space legislation. According to the South African legislation "'outer space' means the space above the surface of the earth from a height at which it is in practice possible to operate an object in an orbit around the earth."[293] This definition does indicate that a fixed boundary exists, but it bases the location of that boundary on the ability of an object to orbit, effectively placing its national definition in line with the lowest perigee of an orbiting satellite definition proposed by some spatialists, and possibly the location of a customary law boundary.[294]

Although no other States have yet included a definition of outer space in their national space legislation, it is possible that the increase in commercial launch activity will lead other States to follow the path taken by Australia. To the extent future national legislation containing such a definition adheres to something close to the 100 km mark as Australia has done, it will strengthen the argument for a customary law boundary existing at that altitude. In any case, if more States feel compelled to place a definition in their national legislation, the argument within the COPUOS that there is no need for a boundary will be weakened, especially if the States including boundary definitions in their national legislation are among the major space powers and launch providers.

E. Chapter Summary

The legal regimes governing airspace and outer space are based on fundamentally different principles, making it clear that the two regions are separate and distinct. Despite having over half a century to debate the issue, international lawmakers have not yet been able to provide an answer as to the location of the boundary between airspace and outer space. While the COPUOS has endlessly debated the issue for decades, the scope of

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precise definition of the term 'outer space' had led to uncertainties with respect to what launch activities were covered by the Australian Space Activities Act of 1998").

293 *Space Affairs Act*, No. 84 of 1993, s. 1.

294 Of course if new technology were developed that had the ability to orbit at lower altitudes, under the South African legislation it appears that the space boundary would change to accommodate such developments.

space activities has been constantly evolving. At the beginning of the space age the view that there was no need to settle the boundary issue may have seemed reasonable and perhaps even appropriate given the early stage of development of space activities; it is no longer reasonable or appropriate today.

Given the increased role of private enterprise in space activities, including the development of commercial spaceplanes and spaceports, as well as the emergence of a viable space tourism industry, the question of the air/space boundary can no longer be left unsettled. The lack of a defined boundary introduces significant legal uncertainties into an emerging industry. When outer space was the near-exclusive playground of States these uncertainties may have been acceptable, but they are not acceptable in an industry that has attracted (and needs to continue to attract) increased commercial investment and development interest.

CHAPTER III.

THE URGENT NEED TO RESOLVE THE AIR/SPACE BOUNDARY ISSUE

The lack of a legally recognized boundary between airspace and outer space is not simply an abstract issue that can continue to be the focus of unproductive international debate as it has been for the past half century. While some States may argue there is no need to establish a boundary because the lack of a boundary has not had an appreciable effect on space activities, the argument is losing force. If the fact that airspace and outer space are legally two distinct regions is not, of itself, reason enough to resolve the delimitation question, there are also numerous legal issues that are directly linked to the lack of a defined boundary. While these issues may have lain dormant in the past, new technologies and the growing involvement of private entities in space activities are increasing the likelihood that such issues will become more than theoretical causes for concern in the near future.

A. Old Law and New Technology

The OST entered into force in 1967, a time when outer space really was a new and unknown frontier. It had only been a decade earlier that Sputnik, the first manmade satellite, was launched into orbit, and the substantive content of the OST was based on principles that began to take form almost immediately thereafter.[295] In 1967, as had been the case since the beginning of the space age, the U.S. and the U.S.S.R., the two space powers and global superpowers, were in the midst of the Cold War.[296] The two

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[295] See generally Jasentuliyana, *supra* note 265 at 2 (noting "[t]he first concrete steps in the regulation of the peaceful uses of outer space were taken by the United Nations General Assembly shortly after the first space launch"); *ibid.* at 23 (referring to the "space law-making process" beginning in 1958 with the establishment of the *ad hoc* Committee on the Peaceful Uses of Outer Space).

[296] See generally Kevin Madders, *A New Force at a New Frontier* (Cambridge: Cambridge University Press, 1997) at 9 (noting that "[b]y 1960, technology R&D had become the surrogate battleground of the Cold War, with the U.S. and USSR each spending over $20 billion at prevailing values on all R&D in that year"); *ibid.* at 10 (noting "the Cold War and the beginning of the Space Age were inseparable. The space race which took place in the 1960s would, indeed, provide the kind of direct technological and ideological contest between the behemoths of applied science that, if transposed to the military sphere, would have spelt Armageddon."); Roger D. Launius, "Historical Dimensions of the Space Age" in Eligar Sadeh, ed., *Space Politics and Policy: An Evolutionary Perspective* (The Netherlands:

superpowers dominated all aspects of space exploration, using their respective space-related accomplishments as Cold War propaganda tools, each hoping to be the side that would score the next victory in the "space race."[297]

Not only was outer space dominated by two States, it was dominated by two governments. Private space activities were non-existent; the respective superpower governments controlled launch capabilities and astronauts were chosen from among military personnel.[298] Because space technology and military technology were often one and the same, access to such technology was severely restricted on the basis of national security.[299] Quite simply, space exploration came about in an era which dictated it be a predominantly governmental activity, undertaken largely for governmental purposes.[300]

Kluwer, 2002) 3 at 3 (stating "[i]t is a common understanding that the space exploration program of the United States was born out of the Cold War rivalry between the US and the Soviet Union in the latter 1950s").

297 See *e.g.* Ronald D. Humble, *The Soviet Space Programme* (London and NY: Routledge, 1988) at 5 (stating "with its beginnings in the 1950s, the Soviet-American 'space race' accelerated during the 1960s, partially as a contest for international political prestige, and partially through true fear of each opponent's gaining military supremacy though the mastery of space technology"); William Shelton, *Soviet Space Exploration: The First Decade* (London: Arthur Barker Limited, 1968) at 4 (noting Soviet "space achievements won them such immediately recognizable respect that their adept propagandists quickly formulated two new myths: space milestones, they claimed, had suddenly made them the world's leading technological nation; and achievements in space were, in their eyes at least, proof of a superior form of government").

298 See generally Stephen B. Johnson, "Space Business" in Eligar Sadeh, ed., *Space Politics and Policy: An Evolutionary Perspective* (The Netherlands: Kluwer, 2002) 241 at 241 (noting that "[a]t the beginning of space exploration, government policy defined the existence, goals, and means to create space vehicles and operations"); *ibid.* at 243 (stating "the government's goals and contracting policies defined the framework of space business. For the first several decades of space activities, this was by far the dominant type of space business."). Private businesses were involved in the industry, but for the most part these were defense and related companies that were government contractors, such as Lockheed, Boeing, Douglas, etc. See generally *ibid.* at 254 (noting that "[f]rom the standpoint of private business, NASA was a potential new source of government contracts, using essentially the same procurement process as the DOD").

299 See generally Roger Handberg, "Rationales of the Space Program" in Eligar Sadeh, ed., *Space Politics and Policy: An Evolutionary Perspective* (The Netherlands: Kluwer, 2002) 27 at 34 (stating "[n]ational security, operating as the justification for space activity, reflected the historical context of the Cold War, an international political-military-economic competition occurring between blocs led by the US and the Soviet Union respectively. In 1957, those alliances were locked in an intense duel for world leadership; space activities were incorporated into that competition because of their military relevance."); Humble, *supra* note 297 at 5 (noting that the "aggressive Soviet strategic posture stimulated similar developments in the United States, and scientists in both countries based plans for space exploration upon increasingly powerful military boosters and other dual application technologies"); *ibid.* at 61-64 (discussing the creation and background of the Strategic Rocket Forces,

The east-west polarization that dominated global politics in the formative years of the space age was the driving force behind the drafting of the OST, which was shaped predominantly by the politics and realities of the Cold War.[301] Without the backing of both the U.S. and the U.S.S.R., the only States with space capabilities, the OST would have been meaningless.[302] The OST was carefully drafted almost exclusively by the U.S. and U.S.S.R.,[303] meaning that many of its fundamental principles are the direct result of Cold War politics and compromise, which also accounts for the intentional vagueness of many principles and the failure to define key terms.[304] The OST was the best agreement that could be reached at the time; a compromise between two antagonistic States that effectively controlled the field of space exploration. However, in the nearly forty years

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"a key element of the overall Soviet space programme," which was "the largest missile force in the world, controlling all Soviet land-based ICBMs, IRBMs, and MRBMs").

300 See generally Handberg, *supra* note 299 at 30 (explaining the Sputnik launches "created the strong pressures for making space policy an adjunct of national security policy rather than emphasizing the pursuit of peaceful activities, such as scientific exploration and commercial development. The concern for national security drove the field for years, and still remains an important issue.").

301 See *e.g.* Matte, *supra* note 207 at 265 (describing discussions in the COPUOS Legal Subcommittee leading up to the OST as "nothing more than interrupted and resumed debates, of an evolutionary nature, changing as the interests of the United States and the Soviet Union developed in line with technical improvements and outer space experiments"); Goldman, *supra* note 236 (stating that "[t]he history of international space law, therefore, cannot be understood apart from its origins in the Cold War . . . the development of the international law of outer space is inextricable linked to this context of international politics and policy").

302 See *e.g.* Cheng, *supra* note 209 at 128-29 (discussing the fact that without the agreement of the two superpowers, it would have been impossible to proceed with the development of space law and noting that "it was stressed by almost all the [COPUOS] delegates, the essential point was agreement between the two space powers"); *ibid* at 156 (noting that leading up to the presentation of a draft of the OST to the COPUOS, "the really crucial discussions took place between the two space powers").

303 See generally Matte, *supra* note 207 at 319 (explaining that the OST "resulted from the agreement of two Great Powers, the United States and the Soviet Union, to subscribe, together with as large a percentage of the international community as possible, to a Declaration of Principles already accepted in the United Nations"). See also *ibid.* at 287-320 (describing the compromises included in the OST and the dominant role played by the U.S. and U.S.S.R. in determining its form); Cheng, *supra* note 209 at 684 (stating, with respect to the text of the OST, "the crucial issue at all times was whether the provisions were acceptable to the Soviet Union and the United States, and much of the negotiation took place directly between them. Once they were able to reach agreement, then the rest became largely a formality.").

304 See generally Matte, *supra* note 207 at 301 (noting that "whereas several states expressed disappointment at the permissibility of certain military actions in outer space, on the moon and other celestial bodies, the United States and the Soviet Union agreed on avoiding an answer, declaring that it would be impossible to give one at this time"). See also Cheng, *supra* note 209 at 219-26 (describing the negotiations between the U.S. and U.S.S.R. leading to the OST).

that have elapsed since the OST entered into force, the politics, players, and technology of space exploration have undergone significant changes.

The changes that have taken place in the space industry since the drafting of the OST have been dramatic; many of the fundamental assumptions the OST was based upon are now obsolete. The Cold War that gave birth to the space race and drove development in the early years has been over for more than a decade. Space access and exploration are no longer limited to two powerful governments. The number of States with space programs has increased significantly, with several becoming major players in the space industry.[305] More notably, States no longer dictate the perimeters of space exploration, nor do they control access to space.[306] Private companies have the ability to reach outer space; private citizens can even visit space as space tourists.[307] Today private sector investment in space-related ventures is steadily increasing, leading to a corresponding increase in privately developed space technologies.[308] As a result, private entities and

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[305] See *e.g.* Nandasiri Jasentuliyana, "Future Space Applications, Including the Future Framework Within the United Nations" in Chia-Jui Cheng, ed., *The Use of Air and Outer Space: Cooperation and Competition* (Netherlands: Kluwer, 1998) 369 at 375 ["Future Applications"] (stating "[t]he developing countries are becoming increasingly involved in the use and exploitation of outer space . . . resulting [in] . . . a greater number of nations participating in the law-making process of the United Nations – some of whom have to take cognizance of the large financial stakes of their private entities involved in space activities – often on very technical issues, has led to the process of law-making becoming tedious and time-consuming, with long, drawn-out negotiations and debates").

[306] This is not to suggest that States exercise no control over space activities. To the contrary, the space industry is generally highly regulated due to security concerns over dual use technology, safety aspects, and other issues. The U.S., for example, has a large body of domestic law dealing with outer space activities in general and commercial activities specifically. See generally *Commercial Space Launch Act of 1984, as amended*, 49 U.S.C. §§ 70101 et seq. (2006) (including relevant portions of the Commercial Space Launch Amendments Act of 2004) [*CSLA*]; *Commercial Space Act of 1998*, 42 U.S.C. §§ 14701 et seq. (2006); *Commercial Space Transportation Competitiveness Act of 2000*, Pub. L. No. 106-405, 114 Stat. 1751 (codified as amended in scattered sections of 49 U.S.C.); *Commercial Reusable In-Space Transportation Act of 2002*, 42 U.S.C. §§ 14751 et seq. (2006);*Commercial Space Launch Amendments Act of 2004*, Pub. L. No. 108-492, 118 Stat. 3974 (codified as amended in scattered sections of 49 U.S.C.); *Commercial Space Transportation Regulations*, 14 C.F.R. § 400 et seq. (2006).

[307] See Chapter I.A.1 and Chapter I.B, above, discussing commercial spaceplane development and commercial space activities.

[308] See generally James A. Vedda, "Space Commerce" in Eligar Sadeh, ed., *Space Politics and Policy: An Evolutionary Perspective* (The Netherlands: Kluwer, 2002) 201 at 202 (noting "[c]ommercial activity in space has become a large and rapidly growing area of activity . . . [and] has moved into the mainstream of business and investment"); *Ibid.* at 215 (stating that "in 1997, both in the US and

commercial enterprises are now in the position to significantly influence the future of space exploration.

Just as those who control and produce space technology have changed over the years, the technology itself has also undergone significant changes. Technology such as the space elevator, science fiction when the space age began, now looks like something that could become a reality in the not too distant future. While space access today is still largely accomplished through the use of large booster rockets, spaceplane technology (at the moment the basis of suborbital tourism ventures) is blurring the distinction between airspace and outer space.

Taken together, the changes in the politics, access to, and technology of outer space have fundamentally changed the face of space exploration. These fundamental changes have highlighted problematic areas in the existing international space law regime. Perhaps the most basic problem is the lack of a defined boundary between airspace and outer space (or the failure to define 'outer space') in international law. The uncertain air/space boundary gives rise to several issues that will need to be resolved in the upcoming years.

B. Problems Caused by the Lack of a Boundary

1. Blurring the Line Between Aircraft and Spacecraft

Air travel has become part of our everyday lives; a means by which we travel from place to place in various aircraft. Space travel is not yet part of everyday life, but it is continually becoming more commonplace, with several different types of spacecraft (or launch vehicles) able to reach outer space. But, legally speaking, what is an 'aircraft'? And what is a 'spacecraft'? What are the differences and distinctions and what happens when some of those differences and distinctions begin to blur?

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worldwide . . . private sector space revenues exceeded government space expenditures, and the number of commercial payloads launched into space exceeded the number of government payloads" for the first time since the beginning of the space age and "[t]his trend is expected to continue, increasing the private-sector share of global space activity for the foreseeable future").

The most often cited public international law definition of 'aircraft' is found in Annex 2 of the Chicago Convention.[309] Annex 2 defines "aircraft" as "any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface."[310] This definition is broad, including most anything that "*can* derive support" from the air within its scope.[311] This definition is not, however, exclusive. Other treaties and various national laws contain their own definitions of "aircraft."[312] Furthermore, as the Chicago Convention is applicable only to civil aviation, its definition of 'aircraft' arguably does not even cover the field in public international air law, as State (and military) aircraft could potentially be defined in another way by different States or even agencies within States.[313]

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309 ICAO, *Annex 2 to the Convention on International Civil Aviation, International Standards: Rules of the Air*, ICAO Doc. AN 2, at ch. 1 [*Annex 2*]. Annex 2 separately defines "aeroplane" as "[a] power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight," which clearly indicates that airplanes are a subset of the broader aircraft category. *Ibid.*

310 *Ibid.*

311 There is no requirement in this definition that the machine *actually* derive support from the air, which could allow machines not actually intended as aircraft to technically fall within the definition if they were able, due to design particulars, to derive support from the air (regardless of whether they actually are doing so during flight). For example, some rockets technically could derive support from the air, though they do not do so during flight. See *e.g.* Diederiks-Verschoor, *supra* note 201 at 5 (noting that "Second World War flying bombs (V-1)" were capable of deriving support from the atmosphere). See also Laurence R. Newcome, *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* (Reston, VA: AIAA, 2004) at 140 (referring to the 12 June 1944 flight of a German V-1 cruise missile as "the first combat use of unmanned *aircraft*") [footnote emphasis added].

312 See generally *Federal Aviation Act*, 49 U.S.C. 40102(a)(6) (2006) (establishing that under U.S. law "'aircraft' means any contrivance invented, used, or designed to navigate, or fly in, the air"). Exactly what contrivances fulfill the definition of "aircraft" is left to the sole discretion of the FAA administrator, and could potentially be defined more broadly than in Annex 2 of the Chicago Convention. See generally *Fielder v. United States*, 423 F. Supp. 77 (C.D. Cal. 1976) (holding that "aircraft" is defined "in a broad and general manner, thus leaving to the sole and sound discretion of the Administrator the duty of determining what devices constitute aircraft within the meaning of the Act").

313 Article 3(b) of the Chicago Convention establishes "[a]ircraft used in military, customs and police services shall be deemed to be state aircraft." This is a functional definition; it is the use to which the aircraft is put that determines its status as a civil or State aircraft (rather than being based on the type of aircraft), with State aircraft limited to those that are used in "military, customs and police services." Consequently, it would be possible for the same aircraft to be either a civil or State craft, depending on its use at any given time. While The Chicago Convention sets out what a State aircraft is, and excludes such aircraft from its scope, there is nothing in the Convention which would prevent individual States, departments of defense, and the like, from defining "aircraft" in different ways to serve their internal purposes. See *e.g. supra* note 312 (referencing the U.S. definition).

The public international law definition of 'spacecraft' is even more uncertain than that of 'aircraft.'[314] The OST refers to "an object launched into outer space" in Article VII, further providing that the launching State of the object is liable for damage caused "by such object or its component parts."[315] In Article VIII the OST refers to "an object launched into outer space," in this instance establishing that the State of registration maintains jurisdiction and control over its space objects and their component parts.[316] In Article XII the OST switches terminology, referring to "all stations, installations, equipment and space vehicles on the moon and other celestial bodies."[317]

The OST never defines exactly what "an object launched into outer space" is, though it is evident the terminology is used broadly so as to encompass a wide variety of objects and any parts of those objects, in effect including anything and everything that is launched into outer space.[318] However, if 'space object' is intended to be an all-inclusive definition, then the listing of various objects in Article XII must have been with the intent to exclude certain objects that would otherwise fall into the space object category.[319]

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314 In fact, 'spacecraft' is not the terminology of choice in the public international space law treaties. Although the term 'spacecraft' does appear in certain of the treaties, 'space object' is more commonly used throughout the treaties. See Cheng, *supra* note 209 at 493 (stating "[t]he expression 'object launched into outer space' is one of the most commonly used in the various United Nations sponsored treaties relating to outer space"). See also *ibid.* at 464 (noting "[t]he expression 'space object' is, however, not specifically defined in any of the conventions relating to outer space established under the auspices of the United Nations, notwithstanding efforts to do so in the negotiations leading to the Liability Convention and the Registration Convention").

315 *OST*, *supra* note 226 at art. VII.

316 *Ibid.* at art. VIII. The OST also refers to "space objects" in Article X, which provides that States must give consideration to requests of other States Parties "to observe the flight of space objects launched." *Ibid.* at art. X.

317 *Ibid.* at art. XII.

318 See generally Cheng, *supra* note 209 at 464 (explaining "the term space object designates any object which humans launch, attempt to launch or have launched into outer space. It embraces satellites, spacecraft, space vehicles, equipment, facilities, stations, installations and other constructions, including their components, as well as their launch vehicles and parts thereof.").

319 If this were not the case, it would seem to have made more sense for Article XII to simply have referred to 'space objects,' rather than specifically listing out individual items that would be included in the more broad term 'space objects.'

However, because neither 'space object' nor any of the listed objects are defined in the OST, it is not immediately clear what is being excluded.[320]

Both "space object" and "spacecraft" appear in the text of the Rescue Agreement, but 'space vehicle' does not.[321] Articles 1-4 refer to "spacecraft," and discuss the duties of the States Parties with respect to the personnel of spacecraft that are in need of assistance due to an accident, distress of some sort, an emergency, or an unintentional landing.[322] Article 5 then switches terminology, returning to that used in the OST, in setting out the duties of States Parties with respect to "a space object or its component parts."[323]

The distinction between "space object" and "spacecraft" in the Rescue Agreement seems to be based upon whether or not the vehicle was manned. The term "space object" is used in Article 5, which limits its content to those obligations relating directly to the object; personnel are never discussed.[324] However, in Articles 1-4 the emphasis is on the duty to rescue and return the personnel, and in these articles the term "spacecraft," rather than "space object" is consistently used.[325] Consequently, the impression given by the context of the Rescue Agreement is that "spacecraft" must be manned and "space objects" are unmanned.[326]

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320 If the purpose of Article XII is to distinguish among objects, all which could conceivably be classified as "space objects," we know for certain that not all "space objects" are spacecraft or "space vehicles." Although the term "spacecraft" is not used in the OST, it is possible that there is some difference between a spacecraft and the mentioned "space vehicle," since no definition is provided and subsequent treaties use both "spacecraft" and "space vehicle." See Cheng, *supra* note 209 (commenting that OST Article XII "*distinguishes* 'space vehicles' on celestial bodies from 'stations, installations, [and] equipment'") [emphasis added]. But see *ibid.* at 462 (noting "spacecraft and space vehicles appear to have been treated as synonymous terms in treaties relating to outer space concluded under the auspices of the United Nations").

321 *Rescue Agreement*, *supra* note 226 at art. 1-5.

322 *Ibid.* at art. 1-4.

323 *Ibid.* at art. 5.

324 *Ibid.*

325 *Ibid.* at art. 1-4.

326 This then leads to the question of what terminology would apply in a situation where, in outer space, the personnel abandoned their malfunctioning "spacecraft," which subsequently crashed to Earth. If the presence or absence of personnel at a given moment determines whether something is a spacecraft

Article I of the Liability Convention provides that "[t]he term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof."[327] The Liability Convention then proceeds to discuss launching State liability for "space objects."[328] The Liability Convention consistently uses "space object" throughout its text and does not use the term 'spacecraft' or 'space vehicle' at any point.[329]

The Registration Convention defines "space object" in exactly the same manner as the Liability Convention: "[t]he term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof."[330] The Registration Convention establishes that launching States are responsible for registering their "space objects."[331] The term 'spacecraft' does not appear in the Registration Convention. However, the Registration Convention does seem to make an interesting distinction between a "space object" and "objects launched into space."[332] The implication that not all objects in space are necessarily 'space objects' adds further uncertainty to the scope of

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or a space object, any given vehicle could be either at any time. If the question is whether a given vehicle was meant to have personnel onboard in order, for example, to operate correctly, then the definition such vehicle would be more stable. See Cheng, *supra* note 209 at 500 (noting "it would appear from their frequently linked references to astronauts and personnel that space vehicles and spacecraft are simply space objects actually carrying, or capable of carrying, persons and/or cargo . . . they do not occupy a legal category of their own, although in due course they and other means of transport in space, such as space tugs and space shuttles, may all require special regulation").

327 *Liability Convention*, *supra* note 226 at art. I(d).

328 *Ibid.* at art. II-VI.

329 Cheng, *supra* note 209 at 493 (noting that the Liability Convention "adheres most faithfully to the term 'space object'").

330 *Registration Convention*, *supra* note 226 at art. I(b).

331 *Ibid.* at art. II, IV-VI.

332 See Cheng, *supra* note 209 at 493-95 (noting that the Registration Convention uses the phrase "space object" and also "objects launched into space," and speculating as to "whether there are objects launched into outer space that are not 'space objects'" and further wondering if "Article II(1) of the Registration Convention really intend[ed] to say that a distinction exists between simple 'objects launched into earth orbit and beyond' as distinguished from 'space objects launched into earth orbit and beyond'").

the definition of 'space objects,' as well as to how 'spacecraft' fit within that definition and international space law.[333]

Finally, the Moon Agreement, like the OST, uses varied terminology. Article 3 prohibits hostile action against "spacecraft, the personnel of spacecraft or man-made space objects."[334] Article 8 of the Moon Agreement speaks of both "space objects" and "personnel, space vehicles, equipment, facilities, stations and installations."[335] Subsequent articles employ the terminology from Article 8,[336] although "space objects" are mentioned again only once, in Article 13.[337]

In specifically mentioning "spacecraft" and "man-made space objects" separately in the same sentence, the Moon Agreement indicates that there is a difference between

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[333] *Ibid.* See also *ibid.* at 495 (noting "[o]ne is consequently given no help by . . . the Registration Convention in one's search for a definition of 'space object' or a clarification of its meaning").

[334] *Moon Agreement*, *supra* note 226 at art. 3(2).

[335] *Ibid.* at art. 8. Article 8(a) refers to space objects as things that can be *landed* on or launched from the moon, whereas Article 8(b) refers to "personnel, space vehicles, equipment, facilities, stations, and installations" as things that can be *placed* "anywhere on or below the surface of the moon." Logically any of the items in 8(b) had to arrive at the moon, likely in a space object that landed there. Since a "space object" is defined in other of the space treaties as including its "component parts" and "launch vehicle," the question naturally arises as to whether such items carried to the moon in a space object once constituted part of the space object and remained so until they were offloaded, or if they were always separately categorized items. If they were always separately categorized items, this then raises the question as to what would happen if a space object carrying such items broke apart and caused damage on the Earth within the meaning of the Liability Convention. If the items were not considered space objects or component parts, the launching State theoretically would not be liable for damage they caused. See *Liability Convention*, *supra* note 226 at art. II (making a State liable for "damage caused by its *space object*") [emphasis added]. However, Article IV.1.(b) of the Liability Convention separately mentions "property on board that space object" as something that could potentially *be damaged* by the space object of another State. Because the definition makes clear that a space object includes its component parts, the separate mention of "property on board" suggests that such property is separate from the component parts. Also, because "property on board" is not mentioned as something that could cause damage, it seems that States would not be liable for damage caused by non-component part property (cargo) on their space objects.

[336] *Moon Agreement*, *supra* note 226 at art. 9-13, 15.

[337] *Ibid.* at art. 8.2.(a) (providing that States Parties may "[l]and their space objects on the moon and launch them from the moon"). Interestingly, Article 8.2.(b), which allows States to "[p]lace their personnel, *space vehicles*, equipment, facilities, stations, and installations anywhere on or below the surface of the moon," fails to include "space objects." [emphasis added] In reading subsections (a) and (b) together, it is therefore unclear as to whether "space objects" would include all those objects mentioned in subsection (b) (or at least the component parts of all those objects), whether in order to be a "space object" something must be capable of landing and being launched, or whether a "space vehicle" might be a subset of "space objects."

the two.[338] The Moon Agreement then takes it a step further by making both "spacecraft" and "man-made space objects" subcategories under an apparent grouping of space objects with personnel.[339] This suggests that not all manned space objects are spacecraft, which would mean that something such as the ISS may not be considered a spacecraft.[340] While it is logical that not all manned objects be considered spacecraft, the failure to define any of the various terms in use leaves the exact scope of each term to speculation.

The use of different but similar, and possibly inconsistent, terminology throughout the outer space treaties has done little to settle the question of what a 'space object' is, and, in fact, has only added to the debate and confusion. The term "spacecraft" is specifically mentioned only in the Rescue Agreement and the Moon Agreement, both of which seem to imply that a "spacecraft" must be manned by using the term "spacecraft" only in connection with their "personnel," but no definition exists that either clearly states what a "spacecraft" is, or establishes the relationship between a "spacecraft" and a "space object." The use of additional terms such as "space vehicle," "equipment," and "man-made space objects" only add to the uncertainty.[341]

The lack of a defined air/space boundary serves to further complicate the matter. Because a 'space object,' appears to broadly encompass all objects launched into outer space (as well as their component parts), whether an object is, in fact, a space object is dependent on whether or not it has been launched into outer space.[342] Without knowing where outer space begins, it is impossible to know with certainty whether any given

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338 *Ibid.* at art. 3(2) (prohibiting the use of "the moon in order to commit any such [hostile] act or to engage in any such threat in relation to the earth, the moon, spacecraft, the personnel of spacecraft *or* man-made space objects") [emphasis added].

339 *Ibid.*

340 This distinction makes sense when looking at the obvious differences in technical capability between the ISS and something one would instinctively label as a spacecraft, such as the Shuttle.

341 See generally Cheng, *supra* note 209 at 492 (stating that "[o]wing partly to the speed of the development of astronautics, and partly to a lack of co-ordination, so of the terms and phraseology used in these treaties are increasingly being seen as, if not exactly inconsistent, at least ambiguous, confusing, or inadequate").

342 *Ibid.* at 508 (noting "it would appear that the term 'space object' covers any object launched by humans into outer space, as well as any component part thereof, together with its launch vehicle and parts thereof").

object is indeed a space object. If spacecraft are a subcategory of space objects,[343] regardless of what other confusion may exist with respect to their exact definition, it is impossible to know if something is a spacecraft without knowing if it was launched (or could be launched) into outer space.[344] Consequently, unless the very basis of the definition of 'space object' is changed, the lack of an air/space boundary absolutely prohibits a conclusive determination as to whether or not a given object is indeed generally a 'space object,' or more particularly a 'spacecraft.' Given the increasing prevalence of suborbital flights, and the various technologies used to carry out such flights, the question of whether the vehicles used are aircraft or spacecraft (or space objects) will become more and more important, especially as various legal matters begin to hinge on which classification is applied.

The available definitions of 'aircraft' and 'space object' are vague and incomplete. The Chicago Convention definition of "aircraft" technically applies only to civil aircraft, and then only to those aircraft operating internationally, although it at least can serve as a baseline assessment of what is and is not an aircraft. The primary question that must be asked in determining whether something is an aircraft is whether it can derive support from the air – on its face as simple enough task. However, as the definition of 'space object' is almost nonexistent, complications are introduced into the analysis of whether a given vehicle is an aircraft or a spacecraft. Instead of depending on mechanical capabilities, like the ability (or inability) to derive support from the air, the definition of a space object centers on the ability to reach a certain location, outer space. Because, legally speaking, we do not know with certainty where airspace ends and outer space begins, a problematic gray area is created.

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343 See generally *ibid.* (stating that "[t]erms such as space vehicles or spacecraft cover merely different forms of space object, mainly those used as a means of conveyance").

344 See also *ibid.* at 497 (noting that "[i]t is indeed ludicrous that so many years after the Space Treaty [OST] which clearly distinguishes, for instance, in its Article VII between what happens 'on the earth, in air space or in outer space' one is supposed to be still officially ignorant of, or indifferent to, where in law airspace ends and outer space begins").

An aircraft is an object that can derive support from the air. A spacecraft, as a subset of space objects, is an object that can reach outer space. There are several areas of overlap that can blur the distinction between an aircraft and a spacecraft. The first is the case of a vehicle that can reach outer space and can also derive support from the air, such as the Shuttle, SpaceShipOne, and several other RLV concepts. A second case is that of a vehicle which is capable of deriving support from the air (and in fact does), but travels at such a high altitude that it may technically be in outer space, such as scramjets. Without knowing where outer space begins, it would be impossible to know if such a jet were in fact technically in outer space, and therefore subject to the law of outer space, rather than to the laws of terrestrial airspace. An additional example would be that of 'dual use' craft, meaning vehicles designed with the capability to either travel to outer space, or to fly (in airspace) between points on the Earth, and with the ability to do either, or both, during any given flight.

Technologies like the space elevator, which are intended to transport personnel and cargo to space, also expose problems with the existing definitions. A space elevator, it seems, would not qualify under any definition as an 'aircraft,' but because it is also not 'launched' in any traditional sense of the word, it would not fit into the broad category of a 'space object,' as it is defined by the space treaties.

2. *The Legal Implications of Air Traffic vs. Space Traffic*

Air traffic and space traffic are governed by separate, and fundamentally different, legal regimes. Because territorial airspace is under the sovereign control of the subjacent State, international air traffic regulations must take the sovereign rights of those States into account. Consequently, international air traffic is not free to use all airspace at will, but must instead adhere to the rules set out in various international treaties and agreements.[345]

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[345] See J. David McClean, ed., *Shawcross and Beaumont: Air Law*, Issue 103 (London: Butterworths, 2006) at div. IV, para. 1 [*Shawcross and Beaumont*] (noting that "there is very little customary

As previously mentioned, the primary treaty governing civil aviation is the Chicago Convention.[346] The Chicago Convention sets out the basic framework rules for international air traffic and establishes the ICAO, which is responsible for overseeing the safety of civil aviation. While the basic rules are contained within the Chicago Convention itself, most of the more detailed rules of civil aviation can be found in Annexes to the Convention. These Annexes, which take the form of standards and recommended practices (SARPS), are adopted and amended by the ICAO Council.[347] The difference between a standard and a recommended practice is as follows:

> *Standard* means any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognised as *necessary* for the safety or regularity of international air navigation and to which member states will conform in accordance with the convention.
>
> *Recommended Practices* means any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognised as *desirable* in the interests of safety, regularity or efficiency of international air navigation and to which member states will endeavour to conform in accordance with the convention.[348]

However, "[t]he contracting states are not under any obligation to conform with such [SARPS]; they merely undertake to comply with them so far as they find it

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international law concerning rights in airspace, such rights being almost exclusively a province of multilateral and bilateral treaties").

346 The Chicago Convention also indirectly regulates State aircraft, to a certain extent. Article 3(d) requires that "contracting States undertake, when issuing regulations for their state aircraft, that they will have due regard for the safety of navigation of civil aircraft." This provision effectively requires that individual State regulation of State aircraft work in harmony with the Chicago Convention and the ICAO rules.

347 See *Chicago Convention*, *supra* note 206 at art. 54(l) (making it a mandatory function of the ICAO Council to "[a]dopt, in accordance with the provisions of Chapter VI of this Convention, international standards and recommended practices; for convenience, designated them as Annexes to this Convention; and notify all contracting States of the action taken"); *ibid.* at art. 37 (listing specific matters which standards and recommended practices will address, such as "[r]ules of the air and air traffic control practices," and adding that also included are "such other matters concerned with the safety, regularity, and efficiency of air navigation as may from time to time appear appropriate").

348 *Shawcross and Beaumont*, *supra* note 345 at div. II, para. 13.

practicable to do so."[349] A State that does not comply with the SARPS must file a difference with the ICAO, such that "the differences between its own practice and that established by the international standard" are made known.[350]

The Chicago Convention itself contains numerous restrictions on the freedom of movement of aircraft, such as prohibiting State aircraft from flying over, or landing in, the territory of another State "without authorization by special agreement or otherwise,"[351] requiring scheduled air services to receive "special permission or other authorization" before operating within the territorial airspace of a contracting State,[352], allowing contracting States to refuse cabotage rights to the aircraft of other contracting States,[353] prohibiting the flight of unmanned aircraft over the territory of another contracting State without the "special authorization" of the territorial State,[354] permitting contracting States to create restricted or prohibited zones within their airspace,[355] and requiring that aircraft comply with the relevant laws and regulations of the territorial State.[356] Aircraft must also have certificates of airworthiness, issued by the State of registration, which are to be recognized by other contracting States, so long as the

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349 *Ibid.* See also *Chicago Convention*, *supra* note 206 at art. 37 (providing that "[e]ach contracting State undertakes to collaborate in securing the *highest practicable degree* of uniformity in regulations, standards, procedures, and organization in relation to aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation") [footnote emphasis added].

350 *Chicago Convention*, *supra* note 206 at art. 38.

351 *Ibid.* at art. 3(c).

352 *Ibid.* at art. 6. However, aircraft of contracting States that are engaged in non-scheduled flights are free, subject to certain restrictions of the territorial State and to the terms of the Chicago Convention, to overfly the territory of and make non-traffic stops in foreign contracting States. *Ibid.* at art. 5.

353 *Ibid.* at art. 7.

354 *Ibid.* at art. 8.

355 *Ibid.* at art. 9. Such zones may be created "for reasons of military necessity or public safety." *Ibid.* at art. 9(a).

356 *Ibid.* at arts. 10, 11, 13, 35, 36. Article 35 permits States to restrict the types of cargo that may be carried through their airspace, and Article 36 allows contracting States to "prohibit or regulate the use of photographic apparatus in aircraft over its territory."

certificate was issued pursuant to, at a minimum, the international standards as described in Annexes 6 and 7 to the Chicago Convention.[357]

In addition to the restrictions found in the Chicago Convention itself, Annex 2 contains rules of the air. While Annex 2 is not binding on States as such in territorial airspace,[358] it *is* binding international law over the high seas.[359] Annex 2 contains numerous detailed rules designed to promote the safety of civil aviation, including rules relating to collision avoidance,[360] requirements for filing a flight plan,[361] requirements relating to interactions and procedure regarding air traffic control services,[362] visual and instrument flight rules,[363] and tables of cruising altitudes.[364]

Other agreements with significance for the movement of aircraft include the Transit Agreement,[365] the Transport Agreement,[366] and various bilateral agreements. The Transit Agreement, concluded at the same time as the Chicago Convention, contains the first two freedoms of the air, the freedom to fly through the territorial airspace of another State and the freedom to land in the territory of another State for non-traffic purposes.[367] The Transport Agreement contains three additional freedoms, all relating to the ability to take on or off-load certain categories of passengers, mail and cargo, rather than the ability

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357 *Ibid.* at art. 31; *Shawcross and Beaumont*, *supra* note 345 at div. V, para. 20.

358 As with all annexes to the Chicago Convention, Annex 2 contains SARPS which do not automatically become the rules of the air for contracting States (States may file differences), though States must secure "the highest practicable degree of uniformity in regulations, standards, procedures and organization." *Chicago Convention*, *supra* note 206 at art. 37.

359 *Ibid.* at art. 12 (stating that "[o]ver the high seas, the rules [of the air] in force shall be those established under this Convention"); *Shawcross and Beaumont*, *supra* note 345 at div. VI, para. 3 (stating that "[t]he ICAO rules of the air do not bind the contracting states except over the high seas: thus, national administrations must ensure that aircraft registered by them comply with the provisions of Annex 2 whey flying over the high seas").

360 *Annex 2*, *supra* note 309 at ch. 3.2.

361 *Ibid.* at ch. 3.3.

362 *Ibid.* at ch. 3.6.

363 *Ibid.* at ch. 4, 5.

364 *Ibid.* at app. 3.

365 *Transit Agreement*, *supra* note 206.

366 *Transport Agreement*, *supra* note 206.

367 *Transit Agreement*, *supra* note 206 at art. I(1).

to move through airspace.[368] Perhaps the most important agreements regulating the international movement of civil aircraft are the numerous bilateral treaties in force today.[369] These detailed agreements allow the involved States to create special rights between themselves regarding the movement of their aircraft within the territorial airspace of each party. Together these multilateral and bilateral agreements form the legal basis of transit into and through the territorial airspace of foreign States, placing significant restrictions on the freedom of movement of aircraft, as well as subjecting such movement to a considerable body of both national and international laws, rules, and regulations.

In contrast, the movement of traffic through outer space is essentially entirely unregulated.[370] Because sovereign claims are prohibited, there can be no national boundaries or nationally controlled territories in outer space.[371] At present there are no international 'space traffic' regulations to route or regulate space traffic, meaning, from a legal perspective, space objects have complete freedom of movement in outer space. Furthermore, under existing international space law, all spacecraft have a right of access to outer space; basically anyone that has a spacecraft or space object capable of getting to

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368 *Transport Agreement*, *supra* note 206 at art. I(1). The Transport Agreement is of less importance as it does not have a significant number of contracting States. See *Shawcross and Beaumont*, *supra* note 345 at div. IV, para. 143 (noting that "to date only eleven states are effectively bound . . . the agreement is therefore of les practical importance that was expected when it was originally signed").

369 For a discussion of the standard content and various common forms of bilateral agreements see *Shawcross and Beaumont*, *supra* note 345 at div. IV, paras. 145-75. An additional type of agreement that has recently emerged is the "open skies" agreement. See *ibid.* at div. IV, paras. 176-230.

370 However, while perhaps not technically regulation of the movement of traffic through outer space, it is important to note the ITU's regulation of the GEO. By assigning orbital slots in the GEO, the ITU can perhaps be viewed as directing traffic since once a slot is assigned other space objects may not use that slot, or transit through it (because it is physically occupied). See *e.g.* ITU, "Radiocommunications Sector" (2004) at 7, online: ITU <http://www.itu.int/ITU-R/information/brochure/brochure-BR.pdf> (noting that the role of the Radiocommunication Sector within the ITU is to "effect allocation of bands of the radio frequency spectrum, the allotment of radio frequencies and the registration of radio frequency assignments *and of any associated orbital position in the geostationary satellite orbit* in order to avoid harmful interference between radio stations of different countries") [footnote emphasis added].

371 *OST*, *supra* note 226 at art. II (stating that outer space "is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means").

space, is entitled to enter outer space.[372] This right of access to outer space does not imply a right to use (transit through) the territorial airspace of another State to gain such access, as there is no right of innocent passage for space objects through the territorial airspace of a foreign State.[373] For example, the U.S. has concluded treaties with several foreign governments in order to obtain the right for the Shuttle to enter the air space of those States and use their territory for landing purposes in the event the Shuttle requires an abort landing site.[374] However, the lack of a right of access or innocent passage

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372 *Ibid.* at art. I (stating that outer space "shall be the province of all mankind . . . [and] shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality").

373 See *e.g.* Cheng, *supra* note 209 at 648 (stating "that States exercise complete and exclusive sovereignty over the airspace above their territory with the result that no foreign space objects may fly through it without the permission of the subjacent State"). See also Stephen Gorove, *Developments in Space Law: Issues and Policies* (Kluwer: The Netherlands, 1991) at 358 (noting that the OST "in a sense implies the freedom to go into outer space and also the freedom to return to earth from outer space," but "[b]ecause of the very limited number of space flights that might have traversed through the airspace of a foreign state, the exact nature and scope of this freedom has so far not been determined by customary international law," and further noting that efforts in the UN "aimed at . . . according space-faring nations the right of innocent passage through the underlying airspace above the territories of other countries have to date not received sufficient support").

374 See *e.g. Agreement Between the Government of the United States of America and the Government of the French Republic Concerning the Use Of Istres Le Tube 125 Air Base as a Transoceanic Abort Landing Site*, 7 June 2005, 2005 U.S.T. Lexis 75 at art. 1 (providing that the "French Republic shall authorize the use of Istres Le Tube 125 Air Base . . . for the purposes of assisting in the emergency landing and recovery operations of the United States Space Shuttles . . . exclusively engaged in servicing the International Space Station . . . [t]he Space Shuttle may, subject to the terms of this Agreement, enter and overfly French airspace"); *Agreement Between the United States of America and the Gambia Concerning the Use of Banjul International Airport as a Space Shuttle Emergency Landing Site*, 7 March 1988, 1988 U.S.T. Lexis 169, TIAS 12148, at art. 1 (providing that "[t]he Government of The Gambia approves the use, under the conditions outlined herein, of Yundum Airport as an emergency landing site for the United States Space Shuttles and approves the conduct of necessary preparation, operation, and recovery activities of the United States related thereto"); *Agreement Between the United States National Aeronautics and Space Administration (NASA) and the Royal Moroccan Air Force (RMAF) Concerning the Use of Ben Guerir Air Base as a Space Shuttle Emergency Landing Site*, 28 January 1987, 1987 U.S.T. Lexis 183, TIAS 12209, at art. 1 (providing that "[t]he Kingdom of Morocco approves the use, under the conditions outlined herein, of Ben Guerir Air Base as an emergency landing site for the United States' Space Shuttles and approves the conduct of necessary preparation, operation, and recovery activities of the United States related thereto"); *Agreement Between the Government of the United States of America and the Government of the Republic of Chile Concerning the Use of Mataveri Airport, Isla De Pascua, as a Space Shuttle Emergency Landing and Rescue Site*, 2 August 1985, 1985 U.S.T. Lexis 79, TIAS 11248, at art 1. (providing that "[t]he Government of Chile shall authorize the landing in the event of an emergency, and the recovery from the Airport, of any of the four Space Shuttles which currently exist and are named Atlantis, Challenger, Columbia and Discovery, while these are the property of the Government of the United States and operated by NASA on missions in accordance with the [OST]"); [*Agreement Between the United States and Japan Regarding Space Shuttle Contingency Landing Sites*], 24 January

through foreign territorial airspace should not be taken as a major obstacle to space access because, in drawing an analogy to air law, "States have been fairly liberal in granting transit rights to foreign civil aircraft . . . in either bilateral or multilateral treaties, without treating it as a matter of right under general international law,"[375] a situation which is evidenced by the abort landing site agreements the U.S. has signed with numerous States.

Because the movement and activities of space traffic are subject to almost no international rules or regulations, and air traffic is governed by a well-developed, comprehensive international legal regime, the delimitation question becomes increasingly important as new technologies emerge which are capable of technically being classified as either air traffic or space traffic. The development of spaceplanes, capable of either flying through airspace as air traffic or in outer space as space traffic, and HAPS, capable of operating at altitudes above those of traditional aircraft,[376] will present legal issues, the resolution of which may depend on the establishment of an air/space boundary.

For example, remote sensing of any point on the Earth from outer space is permitted,[377] but sending a military spyplane into the airspace of a foreign State is a

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1985, 1985 U.S.T. Lexis 198, TIAS 12382, at art. 1 (providing that "in the event an emergency landing of the Space Shuttle becomes necessary, the Government of Japan will render all possible assistance so that the Space Shuttle can land on a suitable airfield in Japanese territory to safeguard the lives of the astronauts").

375 Cheng, *supra* note 209 at 648.

376 But see P.P.C. Haanappel, "High Altitude Platforms and International Space Law" in *Proceedings of the Forty-Seventh Colloquium on the Law of Outer Space* (USA: AIAA, 2005) 461 at 462-63 (arguing that, based on the fact that "most authors and authorities agree that this line [air/space boundary] lies somewhere around 100 kilometers above the surface of the earth . . . physically speaking, HAPS operate in air space and not in outer space"). But see Rothblatt, *supra* note 97 at 113 (suggesting that "the stratosphere is not part of airspace as legally defined today, because there is no legal boundary for airspace," and noting that "[t]he stratosphere is above what scientists call 'space equivalent altitude,' and is far above the altitude at which countries seek and obtain overflight permission").

377 See generally *Principles Relating to Remote Sensing of the Earth from Outer Space*, GA Res. 41/65, UN GAOR, 41st Sess. (1986) 115 [*RS Principles*] (allowing remote sensing activities, though narrowly defining remote sensing as "the sensing of the Earth's surface from space by making use of the properties of electromagnetic waves emitted, reflected or diffracted by the sensed objects, *for the purpose of improving natural resources management, land use and protection of the environment*") [footnote emphasis added]; Cheng, *supra* note 209 at 585 (stating that "[a] tacit recognition of its [satellite remote sensing] lawfulness first appeared in the 1972 Treaty between the United States and

violation of the territorial sovereignty of that State.[378] Similarly, the Chicago Convention allows a State to "prohibit or regulate the use of photographic apparatus in aircraft over its territory."[379] Without knowing where territorial airspace ends, it would be impossible to determine if a spaceplane or HAPS (whether civil or military) flying at a high altitude was engaging in permissible remote sensing, or violating the territorial sovereignty of the underlying State.[380] Whether a craft is in airspace or outer space could also have an effect on other legal considerations, such as whether it is necessary to adhere to the Chicago Convention or obey the associated national and/or international air traffic regulations. Because space traffic has significantly greater (nearly unrestricted) freedom of movement than air traffic, being able to differentiate between air traffic and space traffic, and therefore airspace and outer space, becomes increasingly important as new technologies that blur the distinction between the two are developed.

3. *Issues of Liability*

Another legal difference between aircraft and space objects (and air traffic and space traffic) arises from the separate, and mutually exclusive, liability regimes that are

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the Soviet Union on the Limitation of Anti-Ballistic Missile Systems," which allows "national technical means" to be used as a way to verify compliance with the treaty); *Ibid.* at 586 (noting that "[m]ilitary reconnaissance satellites have not only become simply a fact of international life that States just have to learn to live with, but also a vital instrument in the process of arms control and the preservation of international peace").

378 See *e.g.* Cheng, *supra* note 209 at 577 (noting that "[o]n 1 May 1960, the United States sent a U-2 reconnaissance aircraft over the Soviet Union, thus infringing the privacy and sovereignty of the Soviet Union by remote sensing," and further noting that the U.S.S.R. subsequently shot the plane down "to protect its privacy and sovereignty," and that "[t]he right of the Soviet Union under international law to shoot down the aircraft and subsequently to try and, when found guilty, to imprison the pilot was not challenged by the United States"); *ibid.* at 579 (noting that "whilst data gathering from international spaces is lawful, data gathering by one State in the territory of another State, including the latter's national airspace, without the latter's permission, tacit or express, is unlawful").

379 *Chicago Convention*, *supra* note 206 at art. 36.

380 While it may be a rule of customary international law that outer space begins at least at the lowest perigee of existing orbiting satellites, it does not necessarily follow that territorial airspace must extend up to that level. It is possible that a boundary could be set at a lower level, thus effectively extending outer space and limiting territorial airspace; an argument could be made for this lower level based on "near space" where HAPS would operate as having previously been unused and therefore, arguably not within a State's territorial airspace. Therefore, it cannot necessarily be said that anything operating below the lowest perigee of orbiting satellites is necessarily an aircraft and therefore would be violating territorial sovereignty by engaging in remote sensing.

applicable to each. Air carrier liability is governed by a series of private international law instruments that place liability upon the carrier, while liability for space objects is governed by public international law space law treaties which place liability upon the launching State. These fundamental differences are further accentuated by other significant differences in the respective regimes which suggest that the demarcation of outer space may become essential to determining which liability regime is applicable.

International air carrier liability is primarily dealt with through private international law instruments, specifically the systems developed under the Warsaw and Montreal Conventions.[381] The Warsaw Convention of 1929[382] was the first international liability regime specifically applicable to international aviation.[383] The goals of the

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[381] These systems can be characterized as private law because they are directly applicable to individuals, rather than to States.

[382] *Convention for the Unification of Certain Rules Relating to International Transportation by Air*, 12 October 1929, 137 L.N.T.S. 11, 49 Stat. 3000 [*Warsaw Convention*]. The Warsaw Convention was subsequently modified by various protocols, resulting in a rather intricate 'system,' in which various States were party to numerous combinations of the instruments that made up the Warsaw system, meaning that while almost all States adhered to some form of Warsaw, it was necessary to carefully examine the combination of instruments a particular State was party to in order to actually determine the liabilities in any given case. For the text of the other instruments in the Warsaw system see *Protocol to Amend the Convention for the Unification of Certain Rules Relating to International Carriage by Air signed at Warsaw on 12 October 1929*, 28 September 1955, ICAO Doc. 7632 [*Hague Protocol*]; *Convention Supplementary to the Warsaw Convention for the Unification of Certain Rules Relating to International Carriage by Air Performed by a Person Other than the Contracting Carrier*, 18 September 1961, ICAO Doc. 8181 [*Guadalajara Convention*]; *Protocol to Amend the Convention for the Unification of Certain Rules Relating to International Carriage by Air Signed at Warsaw on 12 October 1929, as Amended by the Protocol Done at the Hague on 28 September 1955*, 8 March 1971, ICAO Doc. 8932 [*Guatemala City Protocol*] (the Guatemala City Protocol failed to receive enough ratifications and has never entered into force); *Additional Protocol No. 1 to Amend the Convention for the Unification of Certain Rules Relating to International Carriage by Air*, 25 September 1975, ICAO Doc. 9145 [*Montreal Protocol No. 1*]; *Additional Protocol No. 2 to Amend the Convention for the Unification of Certain Rules Relating to International Carriage by Air, as Amended by the Protocol Done at the Hague on 28 September 1955*, 25 September 1975, ICAO Doc. 9146 [*Montreal Protocol No. 2*]; *Additional Protocol No. 3 to Amend the Convention for the Unification of Certain Rules Relating to International Carriage by Air Signed at Warsaw on 12 October 1929, as Amended by the Protocols Done at the Hague on 28 September 1955 and at Guatemala City on 8 March 1971*, 25 September 1975, ICAO Doc. 9147 [*Montreal Protocol No. 3*]; *Additional Protocol No. 4 to Amend the Convention for the Unification of Certain Rules Relating to International Carriage by Air Signed at Warsaw on 12 October 1929 as Amended by the Protocol Done at the Hague on 28 September 1955*, 25 September 1975, ICAO Doc. 9148 [Montreal Protocol No. 4].

[383] The Warsaw Convention applies only if "international carriage" is involved. Article 1 of the Convention defines "international carriage" as "any carriage in which, according to the contract made by the parties, the place of departure and the place of destination . . . are situated either within the

Warsaw Convention were both the unification of law applicable to international aviation disputes and the limitation of liability faced by air carriers (which were in their formative years in the 1920s and could have been ruined by high damage awards).[384] While a full discussion of the Warsaw system is well beyond the scope of this paper, the important points are the following: the original purpose of the Warsaw Convention was to limit the liability faced by the fledgling aviation industry, and to that end liability ceilings were established;[385] the Warsaw Convention applies only to international transport, with the goal allowing those engaged in such transport to face uniform liability risks;[386] the liabilities assigned under the Warsaw system are borne directly by private entities (air carriers), not by States;[387] the Warsaw system covers liability with respect to both passengers and cargo (including baggage);[388] the Warsaw Convention applies a "modified 'fault' liability with a reversed burden of proof [which] is imposed on the air carrier for death or bodily injury to passengers while on board the aircraft, or in the process of embarking or disembarking;"[389] unlimited liability is applicable in cases of the

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territories of two High Contracting Parties, or within the territory of a single High Contracting Party, if there is an agreed stopping place within a territory subject to the sovereignty, suzerainty, mandate or authority of another Power."

384 See *e.g.* Paul S. Dempsey & Michael Milde, *International Air Carrier Liability: The Montreal Convention of 1999* (Montreal: McGill University Centre for Research in Air & Space Law, 2005) at 11.

385 See *ibid.* at 15; *Warsaw Convention*, *supra* note 382 at art. 22. The limits found in the Warsaw Convention were subsequently raised by various of the Protocols. See *Hague Protocol*, *supra* note 382 at art. XI; *Guatemala City Protocol*, *supra* note 382 at art. VIII (the Guatemala City Protocol has never entered into force; *Montreal Protocol No. 4*, *supra* note 382 at art. VII (raising limits with respect to cargo only). Outside of the Warsaw system, liability limits were also raised by a number of intercarrier agreements and national regulations. See generally Dempsey & Milde, *supra* note 384 at 29-36 (explaining the various intercarrier agreements and national regulations that came into being).

386 *Warsaw Convention*, *supra* note 382 at art. 1; Dempsey & Milde, *supra* note 384 at 11.

387 *Warsaw Convention*, *supra* note 382 at ch. III (discussing the "liability of the carrier"). Note that provisions of Warsaw Chapter III have been amended by various subsequent protocols.

388 *Ibid.*

389 Dempsey & Milde, *supra* note 384 at 14. See also *Warsaw Convention*, *supra* note 382 at ch. III.

air carrier's willful misconduct;[390] and certain defenses to liability are available to the air carrier.[391]

The 1999 Montreal Convention[392] was intended to "modernize and consolidate the Warsaw Convention and related instruments" in order to achieve "further harmonization and codification of certain rules governing international carriage by air."[393] As was the case with the Warsaw system, the Montreal Convention is a private international law convention placing liability directly on the carrier.[394] The substantive liability provisions are set forth in Chapter III of the Montreal Convention, covering death and injury of passengers, damage to baggage and cargo, and delay.[395] With respect to personal injury or death, the carrier is liable "upon condition only that the accident which caused the death or injury took place on board the aircraft or in the course of any of the operations of embarking or disembarking."[396] In cases of personal injury or death, the carrier faces strict liability up to 100,000 SDRs[397] and unlimited presumptive liability

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390 *Warsaw Convention*, *supra* note 382 at art. 25 (as subsequently modified by various protocols).

391 *Ibid.* at arts. 20-21. See also *Hague Protocol*, *supra* note 382 at art. X (eliminating certain carrier defenses contained in Article 20 of the Warsaw Convention); *Guatemala City Protocol*, *supra* note 382 at arts. VI-VII (replacing in entirety Articles 20 and 21 of the Warsaw Convention, though the Guatemala City Protocol never came into effect); *Montreal Protocol No. 4*, *supra* note 382 at arts. V-VI (replacing in entirety Articles 20 and 21 of the Warsaw Convention).

392 *Convention for the Unification of Certain Rules for International Carriage by Air*, 28 May 1999, ICAO Doc. 9740 (entered into force on 4 Nov. 2003) [*Montreal Convention*]. Currently 72 States are party to the Montreal Convention. See ICAO, "Convention for the Unification of Certain Rules for International Carriage by Air Done at Montreal on 28 May 1999" *ICAO Legal Bureau: ICAO Treaty Collection: ICAO List and Current Status of International Air Law Multilateral Treaties*, online: ICAO <http://www.icao.int/icao/en/leb/mtl99.pdf> (listing the States Party to the Montreal Convention).

393 *Montreal Convention*, *supra* note 392 at pmbl.

394 *Ibid.* at ch. III.

395 *Ibid.* at arts. 17-19.

396 *Ibid.* at art. 17(1). The rest of Article 17 details carrier liability for baggage and Article 18 details liability for cargo.

397 SDRs (Special Drawing Rights) are calculated by the IMF, based on the values of "a basket of currencies, today consisting of the euro, Japanese yen, pound sterling, and U.S. dollar." IMF, "Special Drawing Rights (SDRs)" *International Monetary Fund: Data and Statistics* (March 2006), online: IMF <http://www.imf.org/external/np/exr/facts/sdr.HTM>.

amount.[398] The Montreal Convention also contains liability limitations for damages to baggage and cargo, and damages due to delay.[399]

An additional private law convention dealing with liability related to the operation of aircraft is the Rome Convention.[400] According to the Rome Convention, "[a]ny person who suffers damage on the surface shall, upon proof that the damage was caused by an aircraft in flight or by any person or thing falling therefrom, be entitled to compensation."[401] As with the Warsaw system and the Montreal Convention, liability is placed directly upon private entities, in this case the aircraft operator.[402] The policy considerations behind the Rome Convention were also similar to those behind the Warsaw Convention, namely the "desire to ensure adequate compensation for persons who suffer damage cause on the surface by foreign aircraft, while limiting in a reasonable

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398 *Ibid.* at art. 21. The carrier can exonerate itself from liability above the 100,000 SDR mark by proving that the "damage was not due to the negligence or other wrongful act or omission of the carrier or its servants or agents," or that the "damage was solely due to the negligence or other wrongful act or omission of a third party." *Ibid.* at art. 21(2). The inclusion of strict liability is testimony to the fact that carriage by air is now an established industry, such that the low liability limits and more generous defenses available under the Warsaw Convention (for purposes of protecting a fledgling industry) are no long necessary.

399 *Ibid.* at art. 22.

400 *Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface*, 7 October 1952, ICAO Doc. 7364 (entered into force on 4 February 1958) [*Rome Convention*]. Currently 47 States are party to the Rome Convention. See ICAO, "Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface Signed at Rome on 7 October 1952" *ICAO Legal Bureau: ICAO Treaty Collection: ICAO List and Current Status of International Air Law Multilateral Treaties*, online: ICAO <http://www.icao.int/icao/en/leb/rome1952.pdf> (listing the States Party to the Rome Convention). The Rome Convention was subsequently amended. See *Protocol to Amend the Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface*, 23 September 1978, ICAO Doc. 9257 (entered into force on 25 July 2002) [*Montreal Protocol (Rome)*]. Currently 9 States are party to the Montreal Protocol (Rome). See ICAO, "Protocol to Amend the Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface Signed at Rome on 7 October 1952, Signed at Montreal on 23 September 1978" *ICAO Legal Bureau: ICAO Treaty Collection: ICAO List and Current Status of International Air Law Multilateral Treaties*, online: ICAO <http://www.icao.int/icao/en/leb/MtlPr78.pdf>.

401 *Rome Convention*, *supra* note 400 at art. 1(1).

402 *Ibid.* at art. 2. The Rome Convention does "not apply to damage caused by military, customs or police aircraft." *Ibid.* at art. 26. The wording of Article 26 was changed by the Montreal Protocol (Rome). *Montreal Protocol (Rome)*, *supra* note 400 at art. XIII (making the Convention inapplicable to "damage caused by aircraft used in military, customs and police services").

manner the extent of liabilities incurred for such damage in order not to hinder the development of international civil air transport."[403]

The Rome Convention allows the operator to wholly or partially avoid liability if the operator can prove that the damage was solely caused or contributed to by "the negligence or other wrongful act or omission of the person who suffers the damage."[404] Chapter II of the Rome Convention details the limits on liability. The liability limits for damage vary based on the weight of the aircraft, and are limited to 500,000 francs per person in cases of death or injury.[405] However, in the event the damage was caused "by a deliberate act or omission of the operation, his servants or agents, done with intend to cause damage," liability is unlimited.[406]

Public international law applicable to aviation, such as the Chicago Convention, makes no mention of liability, though certain dispute resolution procedures are detailed which could ultimately place liability upon a State for certain aviation related incidents. The Chicago Convention, for example, contains a provision on the settlement of disputes which allows disputes to be brought before the ICAO Council.[407] Decisions of the Council can be appealed to either an arbitral tribunal or the ICJ.[408] However, these provisions in no way make States per se liable for any activities relating to international aviation or aircraft, and damages are not mentioned in any public international air law document.

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403 *Rome Convention*, *supra* note 400 at pmbl.

404 *Ibid.* at art. 6(1). There is also no liability under the Rome Convention "if the damage is the direct consequence of armed conflict or civil disturbance." *Ibid.* at art. 5.

405 *Ibid.* at art. 11. The Montreal Protocol (Rome) replaced the liability limits, using SDRs. *Montreal Protocol (Rome)*, *supra* note 400 at art. III.

406 *Rome Convention*, *supra* note 400 at art. 12.

407 *Chicago Convention*, *supra* note 206 at art. 84. However, the dispute resolution procedure is only for disputes that arise under the Chicago Convention. And, unlike the OST and Liability Convention, the Chicago Convention and its annexes do not make States liable for damage caused by a civil aircraft, regardless of whether the state has registered, granted an airworthiness certificate to, granted an air operator license to, or granted any other certification (or other official documents, recognition, etc.) to the aircraft. Quite simply there is no automatic State liability under the Chicago Convention for any activities of civil aircraft.

408 *Ibid.* at arts. 84-86.

The Warsaw Convention applies to "international carriage . . . performed by aircraft for reward,"[409] however no definition of 'aircraft' is found in the Convention. Because the Warsaw Convention preceded the Chicago Convention by 15 years, the definition of 'aircraft' included in the Chicago Convention cannot be read into the Warsaw Convention,[410] although the term 'aircraft' could be understood to be used as it was defined in the Paris Convention of 1919.[411] The Warsaw Convention also does not indicate the geographical scope of its application (*i.e.*, it does not state that it is only applicable to aircraft flying in airspace). While it is not surprising that in 1929 no thought was given to the potential differences between aircraft and spacecraft and airspace and outer space, none of the subsequent protocols to the Warsaw Convention, most of which were concluded after the beginning of the space age, define aircraft or attempt to limit its application to aircraft that use the airspace in the course of the carriage, or that are in the airspace at the time the damages occur. The Rome Convention, applicable to damage "caused by an aircraft in flight or by any person or thing falling thereform,"[412] makes no attempt to define 'aircraft' or its geographical scope of applicability. The Montreal Convention also does not define 'aircraft,' though in the preamble it does reaffirm "the desirability of an orderly development of international air transport operations . . . in accordance with the principles and objectives of the [Chicago

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409 *Warsaw Convention*, *supra* note 382 at art. 1(1).

410 See *Vienna Convention on the Law of Treaties*, 23 May 1969, 1155 U.N.T.S. 331 at art. 28 [*Vienna Convention*] (stating that treaty "provisions do not bind a party in relation to *any act or fact which took place* or any situation which ceased to exist *before the date of the entry into force of the treaty* with respect to that party") [footnote emphasis added]. But see Shawcross and Beaumont, *supra* note 345 at div. V, para. 1 (stating that the Chicago Convention definition of 'aircraft' "has, it is submitted, become part of international customary law"). To the extent the Chicago Convention definition has become part of customary international law, and given that the Warsaw system has failed to define 'aircraft,' the Vienna Convention would likely apply the Chicago Convention definition to the Warsaw system. See *Vienna Convention*, *supra* note 410 at art. 31 (stating that "[a] treaty shall be interpreted . . . in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose" and "any relevant rules of international law applicable in the relations between the parties").

411 See *Paris Convention*, *supra* note 205 at app. A (defining 'aircraft' as "[a]ny machine that can derive support in the atmosphere from the reactions of the air"). The difference between the Paris and Chicago definitions is, in any case, not significant; the Chicago Convention definition added additional phrasing that was essentially designed to exclude hovercraft from the scope of the definition.

412 *Rome Convention*, *supra* note 400 at art. 1(1).

Convention]," which indicates that the Chicago Convention definition of 'aircraft' would be applicable.[413] Like the Warsaw system, the Montreal Convention fails to define the geographical scope of its application.

Whereas international aviation law places liability directly on private entities, international space law places liability directly on the State for both space objects and space activities, including liability for activities undertaken wholly by private entities. The primary international space law instruments detailing liability for space activities and space objects are the OST and the Liability Convention, which essentially expands upon principles contained in Article VII of the OST. Unlike the Warsaw Convention, where a primary consideration was the protection of a fledgling industry from excessive damage awards, the focus of the international space law liability system is on compensating parties that suffer damages, such damages being the result of activities that were seen as being inherently dangerous and, at the time the treaties were drafted, were essentially exclusively governmental activities.[414]

Under Article VI of the OST States bear "international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities."[415] Article VII further provides that a State "that launches or procures the launching of an object into outer space . . . and each State Party from whose territory or facility an object is launched is internationally liable for damage . . . [caused] by such object or its component parts on the Earth, in air space or in

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413 As with the Warsaw system, the Montreal Convention applies to "international carriage . . . performed by aircraft for reward." *Montreal Convention*, *supra* note 392 at art. 1(1).

414 See *Liability Convention*, *supra* note 226 at pmbl. See also Cheng, *supra* note 209 at 307 (describing the Liability Convention as "a victim-oriented convention").

415 Article VI direct State responsibility for the outer space activities of private entities is an innovation in international law, which generally only holds States directly responsible for their own actions or actions of their agents. See *e.g.* Bin Cheng, "Article VI of the Space Treaty Revisited: 'International Responsibility,' 'National Activities,' and 'The Appropriate State'" (1998) 26 J. Space L. 7 at 15 [Cheng, "Article VI Revisited"] (noting that Article VI "means that every thing that is done by such non-governmental entities is deemed to be an act imputable to the State as if it were its own act, for which it bears direct responsibility . . . and, if damage occurred, [the State is] immediately liable to make integral reparation").

outer space." Consequently, under the OST, *all* liability for damage caused by space activities or objects is placed directly on the State.[416]

The Liability Convention maintains the launching State basis of liability set up in Article VII of the OST and provides further details about the extent of that liability.[417] A launching State is absolutely liable for "damage caused by its space object on the surface of the earth or to aircraft in flight,"[418] while fault-based liability applies to damage "caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State."[419] Unlike the various air law treaties, the Liability Convention contains no limitations on liability, thus exposing States to potentially unlimited liability.

Article VI of the OST, however, does limit its operation to "activities in outer space," which makes it critical to actually know whether or not a given activity is taking place in outer space. Article VII bases liability on damage being caused by objects launched into outer space, therefore also establishing a sort of geographical scope, though a State will be liable for damages caused by the object, regardless of where those damages occur.

The Liability Convention clearly states that it is applicable in cases where damage is caused by a space object, and provides a vague but broad definition of 'space object.' While the Liability Convention is applicable to all international damage caused by a

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416 Because, under international law, liability follows from responsibility, OST Article VI essentially makes States liable for all activities they are responsible for, that being *all* "national activities in outer space." See *Corfu Channel (U.K. v. Albania)*, Merits [1949] I.C.J. Rep. 4, at 23-24 (stating that "it follows from the establishment of responsibility that compensation is due"). See also Cheng "Article VI Revisited," *supra* note 415 at 1o (noting that "responsibility is a broader concept than liability"). Article VII then makes a State additionally specifically liable for any space object for which it could be considered a launching State, regardless of whether that activity would otherwise qualify as a national activity (and therefore fall under Article VI responsibility).

417 *Liability Convention*, *supra* note 226 at art. II-III.

418 *Ibid.* at art. II. A State will be exonerated from absolute liability, assuming its actions conformed to international law, if it can establish "that the damage has resulted either wholly or partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of natural or juridical persons it represents." *Ibid.* at art. VI.

419 *Ibid.* at art. III.

space object, the basis of liability (absolute or fault-based) depends upon where, geographically, the damage occurred and what was damaged.

A number of issues are raised by the definitional shortcomings of both the international air and space law liability documents, many of which are created by the lack of a defined air/space boundary and the introduction of new technologies. For example, would an aircraft that crossed into outer space become a space object, and therefore be governed by the international space law liability regime or is an aircraft an aircraft regardless of whether it is technically in airspace or outer space? If the first suggestion is correct, the labeling of something as an 'aircraft' or 'space object' would be transitory, and knowing where the air/space boundary is would become essential in deciding which regime applies, since emerging technologies (as well, of course, as established RLV technology such as the Shuttle) will be capable of traveling though both airspace and outer space.[420] If the second suggestion is correct (essentially the functional approach) it will be necessary to much more clearly define what 'aircraft' and 'space objects' are, especially given the emergence of 'hybrid' RLVs, scramjets, and other new concepts such as HAPS. Without clear definitions of terms such as 'aircraft' and 'space object,' it would, among other things, be difficult or impossible to determine whether absolute or fault liability would apply under the Liability Convention.[421] Without knowing where outer space begins, it may also be difficult to determine whether a State is a launching State for purposes of the OST and/or Liability Convention; *i.e.*, whether a "launch" within the meaning of the OST and Liability Convention took place, or whether something was simply sent to a high altitude, without being sent into space.[422]

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[420] Under this approach, the applicability of air or space law would essentially be based on the altitude of the craft at the time the damages occurred, which leaves open the issue of what regime would apply if the damages themselves occurred over a period of time, during which the craft crossed from airspace to outer space or vice versa.

[421] Article II of the Liability Convention makes launching States absolutely liable for damage to "aircraft in flight," but under Article III fault-based liability applies if damage is caused to a "space object" that is not on the surface of the Earth.

[422] Although the Liability Convention does not specify where the space object is to be launched, because the Liability Convention elaborates on Article VII of the OST, it is possible to read the two together. Article VII of the OST is more specific with respect to the launch destination, stating that the

Having grown out of separate sets of policy considerations, the regimes governing air carrier liability differ significantly from those governing liability for space objects, making it critical to be able to determine which regime will apply when damage occurs. Although to date there has been no significant confusion with regard to this issue, the emergence of new technologies that blur the distinction between aircraft and spacecraft, as well as changes to the fundamental nature of the space industry, have the potential to bring this issue to the forefront. The question of the location of the air/space boundary may become one of the central issues in determining which regime applies.

4. Commercial Issues

The growth of the commercial space sector, along with the increasing involvement of private entities, gives rise to issues that were not necessarily relevant while the space industry was predominantly controlled by government. While the government budget for space is allocated based on political and national interests, funding for commercial projects is based on factors such as the possibility of profitable returns, the stability of the industry, the risk associated with the investment, the foreseeable demand for products and services, the projected growth of the industry, and other related factors. Uncertainty in these areas, created at least partially by the lack of a legal boundary between airspace and outer space, has the potential to inhibit the growth of the commercial space sector and its associated technological advancements.

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launching is "the launching of an object into outer space." Furthermore, it is questionable RLV, which takes off from a runway like a traditional aircraft, could be said to have "launched" regardless of the destination, as the general term applied to aircraft would be 'takeoff' (so the question becomes whether "launching" is a function of the destination or a function of the technical means of leaving the ground).

a) Financing/Security Interests

The Geneva Convention on the International Recognition of Rights in Aircraft[423] was the first international convention to address rights in aircraft. While the Geneva Convention does not define 'aircraft' it does state that "'aircraft' shall include the airframe, engines, propellers, radio apparatus and all other articles intended for use in the aircraft whether installed therein or temporarily separated therefrom."[424] The scope of the Convention is limited to aircraft in contracting States that are registered in another contracting State, meaning that national law applies to aircraft which are located in their State of registry.[425]

The Cape Town Convention on International Interests in Mobile Equipment[426] establishes uniform standards governing security interests in certain categories of high value mobile equipment,[427] including the means to insure that such security interests are

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423 *Convention on the International Recognition of Rights in Aircraft*, 19 June 1948, ICAO Doc. 7620 (entered into force on 17 September 1953) [*Geneva Convention*]. Currently 87 States are party to the Geneva Convention. See ICAO, "Convention on the International Recognition of Rights in Aircraft Signed at Geneva on 19 June 1948" *ICAO Legal Bureau: ICAO Treaty Collection: ICAO List and Current Status of International Air Law Multilateral Treaties*, online: ICAO <http://www.icao.int/icao/en/leb/Genev.pdf> (listing the States Party to the Geneva Convention).

424 *Geneva Convention*, *supra* note 423 at art. XVI. However, because the Geneva Convention was concluded within the auspices of the ICAO, it is likely that the Chicago Convention Annex 2 definition would apply. See *Vienna Convention*, *supra* note 410 at arts. 31-32. But see Diederiks-Verschoor, *supra* note 201 at 191 (noting that delegate statements at the time of drafting suggest the "idea was to create safeguards for the rights in aircraft intended to participate in international air traffic . . . and the category of aircraft intended to be covered by the Geneva Convention is thus confined to aircraft meant to be used in international air transport"). However, this interpretation does not preclude the use of the technical definition offered by Annex 2, rather it simply advocates using a subset of the aircraft covered by that definition.

425 *Geneva Convention*, *supra* note 423 at art. XI.

426 *Convention on International Interests in Mobile Equipment*, 16 November 2001, ICAO Doc. 9793 (entered into force 1 April 2004)[*Cape Town Convention*]. Currently 10 States are party to the Cape Town Convention (and there are 28 signatories). See ICAO, "Convention on International Interests in Mobile Equipment Signed at Cape Town on 16 November 2001" *ICAO Legal Bureau: ICAO Treaty Collection: ICAO List and Current Status of International Air Law Multilateral Treaties*, online: ICAO <http://www.icao.int/icao/en/leb/capetown-conv.pdf> (listing the States Party to the Cape Town Convention).

427 *Cape Town Convention*, *supra* note 426 at pmbl., art. 2.

"recognized and protected universally."[428] In addition to the Cape Town Convention itself, there are two associated equipment-specific protocols, the Aircraft Protocol[429] and the Space Assets Draft Protocol,[430] which address the particulars with respect to finance of aircraft and space objects.

The Aircraft Protocol applies to "aircraft as defined for the purposes of the Chicago Convention which are either airframes with aircraft engines installed thereon or helicopters."[431] The Aircraft Protocol also specifically defines "aircraft engines"[432] and "airframes;"[433] in both cases the definitions take into account various technical characteristics. Because the Chicago Convention definition is used, the Aircraft Protocol ultimately applies to any "machine that can derive support in the atmosphere from the

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428 *Ibid.* at pmbl. The Cape Town Convention is applicable "when, at the time of the conclusion of the agreement creating or providing for the international interest, the debtor is situated in a Contracting State." *Ibid.* at art. 3(1).

429 *Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Aircraft Equipment*, 16 November 2001, ICAO Doc. 9794 (entered into force 1 March 2006) [*Aircraft Protocol*].

430 UNIDROIT, *Preliminary Draft Protocol on Matters Specific to Space Assets*, UNIDROIT 2004 Study LXXIIJ - Doc. 13 rev., (as revised December 2003), online: UNIDROIT <http://www.unidroit.org/english/publications/proceedings/2004/study/72j/s-72j-13rev-e.pdf> [*Space Assets Draft Protocol*]. The Space Assets Draft Protocol is "currently under consideration by an inter-governmental negotiation process which includes representation by private-sector financiers and the space industry." See UNIDROIT, "International Interests in Mobile Equipment – Study LXXII," *UNIDROIT Work Programme for the Triennium 2006/2008* (25 July 2006), online: UNIDROIT <http://www.unidroit.org/english/workprogramme/study072/main.htm>.

431 *Aircraft Protocol*, supra note 429 at art. I(2)(a).

432 *Ibid.* at art. I(1)(b). Article I(1)(b) states:

> 'aircraft engines' means aircraft engines (other than those used in military, customs or police services) powered by jet propulsion or turbine or piston technology and: (i) in the case of jet propulsion aircraft engines, have at least 1750 lb of thrust or its equivalent; and (ii) in the case of turbine-powered or piston-powered aircraft engines, have at least 550 rated take-off shaft horsepower or its equivalent, together with all modules and other installed, incorporated or attached accessories, parts and equipment and all data, manuals and records relating thereto.

433 *Ibid.* at art. I(1)(e). Article I(e) states:

> 'airframes' means airframes (other than those used in military, customs or police services) that, when appropriate aircraft engines are installed thereon, are type certified by the competent aviation authority to transport: (i) at least eight (8) persons including crew; or (ii) goods in excess of 2750 kilograms, together with all installed, incorporated or attached accessories, parts and equipment (other than aircraft engines), and all data, manuals and records relating thereto.

reactions of the air other than the reactions of the air against the earth's surface,"[434] so long as those 'machines' meet the technical characteristics set out in the Protocol's definitions for "aircraft engines" and/or "airframes."

The policy considerations behind the Space Assets Draft Protocol include "meet[ing] the particular demand for and the utility of space assets and the need to finance their acquisition and use as efficiently as possible," while at the same time keeping in mind "the continuing development of the international commercial space industry and recognizing the need for a uniform and predictable regime governing the taking of security over space assets and facilitating asset-based financing of the same."[435] The Space Assets Draft Protocol defines "space assets" as:

> (i) any identifiable asset that is intended to be launched and placed in space or that is in space;
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> (ii) any identifiable asset assembled or manufactured in space;
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> (iii) any identifiable launch vehicle that is expendable or can be reused to transport persons or goods to and from space; and
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> (iv) any separately identifiable component forming a part of an asset referred to in the preceding sub-paragraphs or attached to or contained within such asset.[436]

The Draft Protocol further states that "[a]s used in this definition, the term 'space' means outer space, including the Moon and other celestial bodies,"[437] and specifies that "[t]he return of a space asset from space does not affect an international interest in that asset."[438]

The definitions used in the Geneva and Cape Town Conventions are relatively certain, in that they make it fairly easy to determine what an aircraft is, and where an aircraft must be located in order to be subject to one or the other of the Conventions. The

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434 *Annex 2*, *supra* note 309 at ch. I.

435 *Space Assets Draft Protocol*, *supra* note 430 at pmbl.

436 *Ibid.* at art. I(2)(g).

437 *Ibid.*

438 *Ibid.* at art. III*bis*.

Space Assets Draft Protocol, however, introduces the possibility of some uncertainty. Because the definitions used in the Draft Protocol are based on the physical presence (or intended physical presence) of the space asset in outer space, the application of the Draft Protocol is dependent on knowing where outer space begins. The definition in the Draft Protocol does nothing to clarify matters, essentially stating that 'space' is 'outer space' – the fact remains that legally, whether it is called 'space' or 'outer space,' there is no international agreement on where it begins.

The Draft Protocol covers assets that are or are intended to be placed in space, or are assembled or manufactured in space. Without knowing where space begins it is impossible to know whether a given asset fits into any of the Draft Protocol's enumerated categories, a situation that would be further complicated in the event such an asset also fit the definition of 'aircraft,' therefore raising the possibility that it could also be subject to the Aircraft Protocol or the Geneva Convention (depending on which is applicable in the relevant State). Space elevators present another interesting scenario; with a tether stretching from the surface of the Earth to outer space, constructed bit by bit by climbing robots, it is essentially constructed partially in airspace and partially in outer space. Would the part of the tether actually constructed in outer space be a space asset, while the rest of the tether would not? Along the same lines, the completed space elevator itself would present an interesting issue as it will extend from airspace to outer space, with part of the whole intended to be in placed in outer space and the rest intended to be placed on the Earth and in airspace.

The Draft Protocol also covers RLVs and ELVs that "*can* . . . transport persons or goods to and from space."[439] The implication here is that these assets would be covered, whether or not they actually *do* transport persons or goods to space, so long as they *potentially could* provide such a service. Aside from the continuing problem of not knowing where space begins, this clause introduces an additional problem – what happens in the case of technology that *could* be used to go to space, but is instead used as

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[439] *Space Assets Draft Protocol*, *supra* note 430 at art. I(2)(g)(iii) [emphasis added].

a form of high altitude international air transportation? What happens when sometimes it is used as air transportation and sometimes as space transportation? Would such a craft be subject to the Aircraft Protocol or the Space Protocol? Finally, with respect to air launch systems, such as SpaceShipOne and its carrier craft White Knight,or some of the scramjet systems, which protocol or convention would apply? Would the carrier craft be a "separately identifiable component forming part of an asset"[440] or would it be subject to the Aircraft Protocol or Geneva Convention, while the 'spaceship' portion was subject to the Space Asset Protocol?

The definitions used in the Space Asset Draft Protocol, coupled with the current lack of an internationally recognized air/space boundary, create uncertainty in an area of the law that seeks to provide certainty and predictability.[441] While it makes sense to define a space asset by referring to its relationship to outer space, such a definition is necessarily dependent on outer space itself being a defined area. So long as the boundary between airspace and outer space remains unsettled, any attempt to define other objects or concepts in relation to outer space, as the Space Asset Draft Protocol is proposing, will have at least some element of uncertainty.

b) FAA/AST Commercial Launch License Regulations

Commercial launches subject to U.S. law are licensed by the FAA/AST pursuant to authority granted by the CSLA.[442] The specific regulations are found in the Commercial Space Transportation Regulations.[443] The emergence of hybrid RLVs, combining aviation and space technology, while making only suborbital flights, has already led to uncertainty as to whether a CSLA license or other FAA commercial

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440 *Ibid.* at art. I(2)(g)(iv).

441 See *ibid.* at pmbl. ("recognising the need for *a uniform and predictable regimen* governing the taking of security over space assets and facilitating asset-based financing of the same");*Cape Town Convention*, *supra* note 426 at pmbl. [footnote emphasis added].

442 See *CSLA*, *supra* note 306. Launches subject to U.S. law (and therefore the CSLA) include all launches from (and reentries to) U.S. territory, as well as all launches by U.S. citizens (as defined in the CSLA) wherever they may be located. *Ibid.* at § 70104(a).

443 See *Commercial Space Transportation Regulations*, *supra* note 306.

aircraft authorizations would be appropriate with respect to certain flights.[444] The FAA recognized the concerns about "knowing, in advance of operation, whether suborbital flight would be regulated under the CSLA and the Commercial Space Transportation Regulations . . . as launch of an RLV that is a suborbital rocket, or under the Federal Aviation Regulations as civil aircraft that must satisfy airworthiness certification requirements,"[445] and acknowledged that:

> Some suborbital RLVs currently under development use traditional aviation technology components, including wings, for lift and glide capability, as well as rocket propulsion for thrust to maintain their trajectory. These vehicles may be termed "hybrid" in nature, because a single vehicle system uses aviation and aerospace technology during different portions of flight.[446]

Under the CSLA a license is required to "launch a launch vehicle."[447] According to the CSLA, 'launch' "means to place or try to place a launch vehicle or reentry vehicle and any payload from Earth (A) in a suborbital trajectory; (B) in Earth orbit in outer space; or (C) otherwise in outer space,"[448] and 'launch vehicle' "means (A) a vehicle built to operate in, or place a payload in, outer space; and (B) a suborbital rocket."[449] Because the CSLA does not define 'outer space,' the clarifications issued by the FAA regarding the applicability of the CSLA and/or FARs to RLVs are based on functionality.[450]

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444 2003 Notice and Request, *supra* note 243 at 26274-75 (noting that "[t]here is concern that uncertainty regarding the applicable regulatory regime may impede the ability of developers of hybrid suborbital RLVs to obtain the financing needed to take their concepts from the drawing board into flight testing").

445 *Ibid.* at 26375.

446 *Ibid.* at 26374.

447 *CSLA*, *supra* note 306 at § 70104(a).

448 *Ibid.* at § 70102(3).

449 *Ibid.* at § 70102(7).

450 See 2003 Notice and Request, *supra* note 243 at 26375 (stating that "[t]he Notice provides *a technical demarcation* between launch vehicles and aircraft so that the public, including vehicle developers, can determine in advance of consultation with the FAA whether a launch license or only aircraft certification is required to conduct flight operations") [footnote emphasis added].

According to the clarifications, "the FAA considers use of rocket propulsion for thrust, as opposed to wing-generated lift, in determining whether a vehicle that flies through airspace is a suborbital rocket under the CSLA, or an aircraft," such that "a suborbital rocket subject to CSLA licensing is a rocket-propelled vehicle intended for flight on a suborbital trajectory, whose thrust is greater than its lift for the majority of the powered portion of its flight."[451] The FAA explained that it "relies upon thrust versus lift during powered flight in differentiating launch vehicles from aircraft because it provides a clear and objective point of demarcation that relies on technical distinctions grounded in the science of physics, not labels."[452] In further explaining why the functional approach is superior to a definition based on altitude, the FAA stated "[a]ltitude is also not an appropriate discriminator for launch vehicles and aircraft because some suborbital rockets, including sounding rockets, are not necessarily intended for launch into Earth orbit or outer space and because aircraft can be designed to operate at increasingly extreme altitudes above controlled airspace."[453]

However, despite these clarifications, it is still possible that an RLV operator will have to obtain "other FAA flight authorization, specifically an experimental airworthiness certificate (EAC), as a condition of a launch license, to operate in the National Airspace System [NAS]."[454] This essentially confirms that, clarifications

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451 *Ibid.* The FAA further noted that:

> Quite simply, a vehicle that relies principally upon rocket-propelled thrust to maintain its intended flight trajectory during powered flight is a launch vehicle, or rocket, subject to licensing under the CSLA unless exempt. A vehicle that relies chiefly upon lift generated by its wings in maintaining its intended course during powered flight is an aircraft subject to regulation under the Federal Aviation Regulations. A rocket-propelled civil aircraft that relies upon wing-borne lift for the majority of its powered flight is not a suborbital rocket requiring a license for operation. The "E-Z Rocket," flown by X-COR, is an example of a rocket-propelled aircraft.

Ibid.

452 *Ibid.* at 26376.

453 *Ibid.*

454 *Ibid.* at 26374. The FAA also noted that "[w]here operation of a launch vehicle includes operation of a civil aircraft for any portion of the flight, an EAC may be required, in addition to a launch license, in order to obtain complete flight authorization for operation in the national airspace system." *Ibid.* at 26376.

designed to tell one class of vehicle from another aside, one vehicle can be both an aircraft and a spacecraft. While the functional approach of the U.S. theoretically would have no issues with this reality, grey areas remain in the U.S. legislation because of the lack of an air/space boundary. Whether a given RLV is an aircraft, a spacecraft, or both, U.S. legislation still defines 'launch' and 'launch vehicle' by referencing that undefined region, outer space. As the FAA itself points out, aircraft can fly at "increasingly extreme altitudes,"[455] and some RLVs are capable of acting as aircraft for at least part of a flight, which leads to the question of when (at what altitude) a given craft ceases to function as a civil aviation aircraft, and instead enters outer space.[456]

While U.S. citizens and those wishing to launch from U.S. territory must follow these laws, which are applicable only within the reach of U.S. jurisdiction, further complications will arise when international travel via RLV becomes a reality.[457] Although the U.S. has a system to assure the safety of its civil airspace and to incorporate RLVs into national air traffic regulations, the lack of a uniform international system, similar to that established for air traffic by the Chicago Convention, will become an issue once suborbital flight becomes more than an 'up and down' space tourism experience confined to the airspace above one State.

C. The Need for Uniform International Regulation, Including Safety Standards

Parallels are often drawn between the early days of aviation and the current stage of development in the commercial space transportation industry, specifically with respect to the inherent risks involved in these emerging industries. The Paris and Chicago

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However, an EAC is subject to numerous restrictions, including severe limitations on where and when the aircraft in question can operate that would seriously impede commercial operations as well as prohibit international flight. Ultimately, it is necessary to have a full airworthiness certificate to operate customer flights within the NAS. See generally 14 C.F.R. §§ 21.81-21.83, 21.191-21.195 (2006).

455 *Ibid.* at 26376.

456 See *ibid.* at 26375 (pointing out that "[u]ltimately, RLV technology may provide trans-atmospheric high-speed flight around the globe, for rapid international travel").

457 See *e.g. ibid.*

Conventions, in combination with the Warsaw system provided an environment in which the fledgling aviation industry could grow, by establishing a system of international regulations reflecting the status of aviation as an emerging source of international transportation services, while protecting an industry that was based on a new and arguably inherently dangerous technology from being stymied by damages claims.

Although to date all space tourism trips have launched from and returned to the same spaceport, with the suborbital journeys essentially encompassing a simple 'up and down' trip, it is not realistic to believe that this situation will continue to be the space tourism model for the foreseeable future.[458] With spaceports being developed not only in multiple locations in the U.S., but also in international locations, future suborbital flights will likely encompass both a trip to space and a flight between two points on the Earth.[459] Once an international transportation element is introduced into suborbital (and ultimately orbital) spaceflights, national laws will not be sufficient to effectively regulate the field.[460]

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458 See Chapter I.B.2, above, for a discussion of space tourism.

459 See Chapter I.B.3, above, for a discussion of commercial spaceport development. It is logical to assume that an international transportation element will be introduced both because of the interest of space tourism companies in developing multiple spaceports, and because of the economic factor – space tourism alone is a smaller market than the transportation of passengers and cargo from point to point on the Earth. At the present time, space tourism is about the destination, but reaching the destination is an end in and of itself, because there is currently nothing to do in space once you get there. This factor may significantly reduce the likelihood of repeat customers. However, the larger market, transportation of passengers and cargo between two points on the Earth, is a proven market, with a proven demand, that will be utilized by customers on a repetitive basis, thus making it the more economically viable space transportation industry.

460 While the U.S. has very detailed legislation dealing with its domestic space activities, and is currently considering items such as safety regulations, other States have little or no domestic regulation in these areas, meaning those engaged in the international space transportation industry will be faced with domestic laws that may have drastic differences each time a spaceflight lands at a different spaceport. It is even possible that in some States the vehicle in question will be considered a commercial aircraft, subject to the international air law regime, while at other locations it would be considered a spacecraft. Avoidance of situations such as these was one of the goals of the Chicago and Warsaw Conventions. See *Chicago Convention*, *supra* note 206 at pmbl. (stating that one of the purposes of the Convention was to allow "that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically"); Diederiks-Verschoor, *supra* note 201 at 59 (noting that under the Warsaw Convention "[t]he passenger knows that, wherever and whenever he flies, there is a certain

Today there is no legal certainty as to where the boundary between airspace and outer space is located, meaning that there is no clear answer to the question about whether air law or space law is applicable in situations involving hybrid craft or even aircraft that are possibly flying outside of airspace.[461] While existing international air law is well-developed, there is no comparable law applicable to outer space. There are no safety standards on the international level governing space transportation, as the Chicago Convention and its associated standards and recommended practices do for air law.[462] Liability is addressed by existing international space law, but it is almost exclusively focused on liability with respect to uninvolved third parties and is entirely placed upon States. On the international level, there is nothing akin to the Warsaw system or Montreal Convention addressing liability to passengers, or limiting the liability of the industry.[463]

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degree of uniformity in the rules governing the carrier's liability, which the carrier, being aware of the extend of his liability, can make arrangements to insure himself against possible losses").

461 See generally Cheng, *supra* note 209 at 647 (stating that "if commercial space flights were to develop, it is essential that the question of the boundary between airspace and outer space should be clearly defined by a treaty, as well as the position of space object, which either by design or by accident, find themselves in or in transit through foreign airspace"); .Jasentuliyana, "Future Applications," *supra* note 305 at 376 (noting that "[a]lthough the foundation of the law regulating space activities has been solidly laid in the space treaties, it is by no means perfect or complete, on account of the political compromises attainable and the technological restraints existing at the time of the adoption of the treaties").

462 See generally Jasentuliyana, "Future Applications," *supra* note 305 at 390 (suggesting that the adoption of standards and recommended practices for outer space may not be appropriate in areas such as the "safety of space operations, manned flight and space navigation," and noting that by so doing it will "fill gaps and weakness in, and supplement, the existing space law treaties and principles").

463 See generally *ibid.* at 377 (noting that "with space activity becoming more of a mainstay of nations rather than a special activity, the application of strict liability may shift to limitation on liability, as it is in the maritime or aeronautical industries").

In the U.S., the FAA has, however, issued proposed rules for human spaceflight, which characterize passengers as "space flight participants," which indicates "that someone on board a launch vehicle or reentry vehicle is not a typical passenger with typical expectations of transport, but someone going on an adventure ride." See *Human Space Flight Requirements for Crew and Space Flight Participants; Proposed Rule*, 70 Fed. Reg. 77262 (2005) at 77269. Consistent with this approach, the proposed rules incorporate the concept of informed consent and permits the operator to require a liability waiver from prospective participants, akin to the approach taken with other inherently dangerous activities, such as extreme sports. *Ibid.* at 77269-77272.

It must be kept in mind that existing space law "provides only the ground rules, which need to be supplemented with additional and detailed norms as the need arises,"[464] and the need has now arisen. Commercial space ventures have reached the point where they need legal certainty to progress to the next level. While too many regulations will undoubtedly be burdensome on, and inappropriate for, an emerging industry, some regulations may be critical for the growth of the industry. Solving the boundary issue will go a long way to providing certainty in many of the key areas, as it would eliminate the question as to which law applies. Regulations that integrate space traffic which is landing and taking off into the air traffic control system, and the further international regulation of 'space traffic' will increase the overall safety of the industry. The next step, after the industry is given time to further develop still new space transportation technologies, would be to implement safety standards applicable to the vehicles themselves and to develop a system similar to Warsaw which limits private law liability to passengers (assuming that initially passengers will be required to sign waivers acknowledging that they are participating in an inherently dangerous activity). Establishing a framework, which takes into account the stage of development of the industry, will provide legal certainty to those in the commercial space transportation industry and will allow the industry to grow according to its technological capabilities, much as the aviation industry did in the first half of the 20th century.[465]

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464 Cheng, *supra* note 209 at 642.

465 One way such a framework could be established would be to amend the Chicago Convention Annex 2 definition of 'aircraft' so that it would include certain types of RLVs that are likely to become part of international air traffic. Because the definition is found in an annex and not the text of the Convention, modification would be easier than attempting to modify the Convention itself. Similarly, it would be far easier to modify the SARPS to include provisions for the regulation of spacecraft than to attempt to negotiate an entirely new treaty system. Because whether they are labeled 'aircraft' or 'spacecraft,' and whether they are defined based on a functional approach or a spatialist approach, spaceplanes will be using the same airspace that is regulated by the Chicago Convention and its annexes, it would be logical to include them within the scope of the Convention. The inclusion of (at least civil) spaceplane technology within the international safety and traffic management standards is a logical next step, because excluding major uses of airspace from regulation could lead to a reduction of the overall safety of the airspace as unregulated objects in the airspace can themselves be seen as hazards.

D. Chapter Summary

The international space law treaties were developed at the beginning of the space age; a time when the political climate was drastically different and the technologies were just being developed. The space law treaties were not intended to be the final word on law in the outer space environment, but rather were intended to create a framework that could be completed as technology developed. Unfortunately, although there have been significant developments in both the utilization of space and space technology, international lawmakers have failed to continue with the development of international space law. The framework treaties created so many decades ago are still, by and large, representative of the existing body of international space law.

It is clear that, from a legal perspective, airspace and outer space are two separate realms, in which two very distinctive bodies of international law are applicable. That being the case, it is logical to conclude that somewhere there must exist a boundary that separates one of these unique legal realms from the other. To this day international lawmakers have not been able to agree on where this legal boundary lies. The inability to establish a boundary is not a legally isolated problem, with no effect on anything else (as was, and still is, frequently argued in the COPUOS and elsewhere).

The lack of a recognized boundary between airspace and outer space has a direct effect on many other legal considerations and is the cause of uncertainty with respect to the application of other areas of the law. When taken in combination with the vague and undefined terms that are used throughout the space law treaties, along with other terms and concepts that are defined based on objects physically being in either airspace or outer space, the lack of a boundary causes numerous legal uncertainties. Such uncertainties are only complicated by emerging technologies that blur the distinction between aircraft and spacecraft and the evolving character of the space industry, which today includes a rapidly growing private sector. By allowing the boundary issue to remain unsolved, a growing industry is exposed to legal uncertainty, the applicable law is in question with respect to many emerging technologies, and the appropriate scope of future laws and regulations remains unclear.

CHAPTER IV.

EVALUATING THE OPTIONS FOR SETTLING THE BOUNDARY ISSUE

The failure of international lawmakers to resolve the air/space boundary issue is attributable to the fact that States are currently divided into two camps, those supporting the functionalist approach and those supporting the spatialist approach. There is also a third group of States that want to 'wait and see' before deciding on which approach to follow. Following either the functionalist or spatialist approach would end the dispute and provide increased legal certainty with respect to outer space activities; whether a fixed boundary is set or it is decided once and for all that a boundary will not be set, international space law ultimately needs to be provided with a more definite 'sphere of influence' in which to operate.

A. The Functional Approach[466]

The States that support the functional approach believe that a fixed boundary should not be set because space activities and/or objects can be (and should be) regulated by space law based on the fact that they are, by their nature, space activities and/or objects.[467] Because functionalists would regulate such activities based solely upon those activities being space activities, a boundary is unnecessary; to functionalists space activities are space activities, and space objects are space objects, regardless of where the activity is taking place or where the object is located.

1. Pros

One advantage of the functional approach is that it naturally incorporates the right of innocent passage, a right which arguably may be required under Article I of the

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466 See Chapter II.C.1, above, for a further discussion of the functionalist views.

467 See *e.g.* Cheng, *supra* note 209 at 445 (stating that the "essence of the functionalists' argument is that the locus of an act need be of no moment to its legality or illegality, which can be determined solely by reference to its nature").

OST.[468] Because Article I proclaims the freedom of outer space, including freedom of access, it is possible to construe it such that a right of innocent passage through foreign territorial airspace is required by international space law, since, without such a right, certain States with limited territorial airspace would be unable to launch space objects from or return space objects to their national territory without violating the territorial airspace of neighboring States.[469] Since Article I of the OST is implies that such access is a right by using the mandatory language "shall," at least theoretically, a State should not have to seek permission from a neighboring State to exercise that right, meaning that a State should not have to negotiate for the right to traverse the territorial airspace of its neighbor to access space, but instead a right of innocent passage should necessarily be implied in international space law (as it would be under the functional approach).[470]

The functional approach may allow for a quicker response to technological changes.[471] While a boundary fixed by international treaty could not be changed without amendment of the treaty, a functional approach would eliminate the need for such time consuming international political and lawmaking processes because it does not incorporate references to a fixed boundary. As a result, advanced 'aircraft' that could fly at a previously unattainable altitude would still be 'aircraft,' and new 'spacecraft' that could potentially orbit at a lower altitude than previously possible would still be 'spacecraft,' thus eliminating any confusion or need for refined definitions that might

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468 *OST*, *supra* note 226 at art. I (stating that "[o]uter space . . . shall be free for exploration and use by all States . . . and there shall be free access to all areas of celestial bodies").

469 See generally Matte, *supra* note 207 at 20 (noting that "the exploration of space takes place in two spheres, each with a different legal status. The take-off and landing of space vehicles require the use of the "territorial" air space . . . while most of the operations themselves take place in the free outer space").

470 See generally *ibid.* at 60 (commenting that "if the states have equal rights to explore space, it goes without saying that a corollary law of *accession* is added to them. But it so, it is difficult to imagine how a small state . . . could send a rocket into space which would not pass through the atmosphere of . . . some other countries before reaching space") [emphasis in original].

471 See generally Myres S. McDougal, Harold D. Lasswell & Ivan A. Vlasic, *Law and Public Order in Space* (New Haven and London: Yale University Press, 1963) at 350 (stating that "[r]apid developments in the technology of flight have already made most of the distinctions asserted in terms of airspace as opposed to outer space largely anachronistic and ill-designed for serving the policy purposes for which they were conceived").

arise under a spatial approach if a new aircraft were to fly in what was defined as outer space or a new spacecraft were capable of orbiting in airspace.[472]

Because international law is intertwined with international politics, it is important to take both legal and political considerations into account.[473] From a political perspective, it may be easier to get States to agree to a functionalist system because it places no 'hard limits' on territorial airspace and can be seen as assuring equal access to space for all States.[474] It is also relevant that the U.S., currently the world's premier space-power, is the leading advocate of the functionalist approach, and remains staunchly opposed to any proposal which would incorporate a fixed boundary. Finally, the functional approach finds additional support among those States that do not believe a boundary is warranted at this time and favor the 'wait and see' approach (though acknowledging that one day a fixed boundary may become necessary).

2. *Cons*

The primary problem with the functionalist approach arises from the fact that air and space are two separate legal realms; existing international law treats airspace and outer space in completely different manners, which indicates that at some point a boundary does exist.[475] It is impossible to have two diametrically opposed legal regimes,

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[472] See generally *ibid.* at 335-36 (noting "the possibility of engineering advances which could upset any particular altitude based upon current technologies").

[473] See generally Matte, *supra* note 207 at 54 (stating that "[t]he fixing of a boundary in the air would also pose *political* and *technical* problems") [emphasis in original].

[474] See generally *ibid.* at 62 (commenting that "only the *functional approach* appears adequate to an efficient cooperation between states, be they powerful or not in the air and in space") [emphasis in original]; *ibid.* at 67 (noting that "it would be easier to bring states into agreement on the qualification of activities than to determine a boundary of the air, as the problem is not regulating two celestial zone according to their altitude but rather, according to the categories of activities which are carried on"); McDougal, Lasswell & Vlasic, *supra* note 472 at 349 (commenting with respect to a fixed boundary that "[t]he extension of national sovereignty to very high altitudes . . . would grievously interfere with all uses of space, without providing any real protection to the unique, exclusive interest of the subjacent states; limiting the comprehensive, exclusive competence of states to a very low height might, on the other hand, seriously interfere with their unique interests").

[475] See Chapter II.B, above, discussing the difference between the legal regimes of airspace and outer space.

governing two separate geographic realms, without there being a demarcation line between the two. Accordingly, "[t]he functionalists' argument is in realty based on false premises; for, insofar as international law is concerned, the initial and most fundamental level of classification is spatial . . . which precedes, and in fact determines, any functional classification whether an activity is lawful or not lawful."[476] Thus, functionalism is essentially an impossible position to support in international law because, regardless of the nature of the activity or object, the legality of the activity or presence of the object is dependent on where, geographically, that activity takes place or that object is located.[477]

A related difficulty is that functionalism appears to ignore the well-established concept of State sovereignty over territorial airspace.[478] According to the functionalist approach, "insofar as space flights are concerned, the concept of airspace sovereignty is irrelevant . . . whatever may be the effects of the principle of airspace sovereignty on

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[476] Cheng, *supra* note 209 at 645 (also observing that "[t]he legality of an act under international law depends in many instances not upon the nature of the act itself but upon where it takes place").

[477] Cheng further observes that:

> What the functionalists are advocating is in effect to brush aside the rule and existence of sovereignty over national airspace in favour of space activities. For non-space powers to embrace it is to renounce part of their territorial sovereignty in favour of other States' space activities. However, even for space powers, the acceptance of such a doctrine can be an act of highly short-sighted complacency; for in claiming their space objects have a right to operate freely in foreign airspace, they would also be renouncing a part of their sovereignty over their own airspace . . . tables can easily be turned one day, and the space activities of other States in one's own airspace may prove highly intrusive. When that happens, States that now embrace functionalism or an arrogant policy of you-don't-need-to-know may well rue their erstwhile craftiness and complacency.

Ibid. at 646.

This does not imply that functionalism is an untenable position with respect to national law. Because national (territorial) airspace is spatially defined, there is no difficulty in declaring, under national law, that spacecraft and activities will be defined on a functional basis within territorial airspace (i.e. there is nothing to stop the U.S. from using a functional approach for purposes of determining whether a U.S. launch license is needed). Similarly, under Article VIII of the OST, the State of registry has jurisdiction and control over space objects in outer space or on a celestial body, meaning that under national law, but only within the sphere of influence of national law, the State of registry is free to use the functional approach with respect to those objects. The difficulty arises when such objects are outside the jurisdictional reach of national law. See *e.g. ibid.* at 444 (stating, by way of analogy, that "[w]hat one can do with or in one's own property does not mean necessarily that one can do it to or in others' properties, at least not without their consent or permission").

[478] See *e.g. ibid.* (commenting that "[u]nder functionalism, States would, therefore, lose the right which they have by reason of their sovereignty, to control or in any way interfere with self-styled 'lawful' foreign space activities in their national airspace").

other matters, such as aerial navigation, it is simply not applicable to space flights . . . if a space activity is authorized by international law, then the flight may thereby take place within the airspace of another State."[479] This approach is more radical than a simple right of innocent passage; what the functionalists are proposing is that any spacecraft may fly through foreign territorial airspace, for any purpose, not just if it falls along the takeoff or landing trajectory, so long as the craft is acting within the bounds of the applicable international space law.[480] This sort of forced 'open invitation' into any airspace and/or outer space location has the potential to create numerous problems besides the violation of a State's sovereign territory, such as conflicts with national laws, conflicts with air traffic routes, potential conflicts with national and international aviation laws, safety problems associated with such conflicts, and national security concerns.[481] Additionally, of course, this is probably the most politically sensitive issue with respect to the functionalist approach because States are not likely to easily agree to a plan which significantly interferes with their ability to exert sovereign control over their territorial airspace.

Another problem with the functionalist approach is that it is absolutely dependent on the ability to differentiate spacecraft and space activities from other objects and activities; without the ability to clearly determine which is which, the functionalist system falls into chaos.[482] Because current international law definitions for 'aircraft' and

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[479] *Ibid.* at 454 (further noting that "[t]his ignores the fact that when people reckon a particular space activity to be compatible with international law, say military reconnaissance, what they have in mind is such activity when conducted in outer space, but never for a moment thereby a right for military reconnaissance satellites to pass through the national airspace of other States, and maybe even operate there while on their way").

[480] See *ibid.* at 397 (noting that under the functional approach "once a space activity has been proclaimed lawful . . . it will not depend on the consent of third States even when such space objects go through the latter's airspace").

[481] See generally McDougal, Lasswell & Vlasic, *supra* note 472 at 355 (stating that "[o]ne possible defect of this [functional] approach, however, may be in its lack of sufficient provision for certain subordinate policies, especially those of a procedural character. It is possible that this approach does not sufficiently take into account either the need for preventing or minimizing disputes or the requirements of economy in the disposition of particular disputes once they have occurred").

[482] There necessarily must be some sort of standard to differentiate, for example, aircraft from spacecraft. If such a definition is not to be based in any way on the geographical location of such craft, it would

space objects are both vague and, to a certain extent, dependent on the physical location of the craft, attempting to introduce a functionalist approach into the current international air and space law legal systems would result in confusion.[483] It would be difficult to know whether something is functionally a space object, without knowing exactly what a space object is. Without knowing where outer space begins, it would seem to be even more difficult to determine whether something was a space activity, since logically a space activity would be an activity that takes place, or is at least capable of taking place, in space.[484] Given these difficulties, a functional system would not be able to provide the clarity and certainty that is needed in international space law, especially in the absence of detailed and precise definitions for the relevant objects and activities.

The function of a space object, for example a spaceplane, also has the ability to vary based on factors which are external to the object itself, especially when no consideration is given to the geographical location in which the operations take place. For example, in the case of a suborbital RLV flight that takes off from one point on the Earth and lands at another, it is possible that some passengers might be on the flight purely *because* it enters space, while others may be taking the suborbital flight because it is the fastest mode of transportation between two points on Earth. In this case, for the passenger that is a space tourist, the suborbital flight is functionally a space activity and that passenger may look at the vehicle as being a spacecraft. However, for the traveler who simply wants to reach his terrestrial destination as quickly as possible, the flight is

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seem necessary to have very detailed technical specifications, which could create problems as technologies advance, hybrid technologies are introduced, and other unforeseen changes take place. See *supra* note 451 and accompanying text.

483 See Chapter III.B.1, above, discussing the current applicable legal definitions.

484 The functionalist approach does not necessarily eliminate the need to define airspace and outer space; rather functionalists believe that space activities remain space activities even if they are taking place in the airspace, and spacecraft remain spacecraft even if they are traveling through airspace. However, at a very basic level something has to differentiate space activities from other activities and spacecraft from aircraft. There seem to be two obvious choices for such a differentiation, one based on technological capabilities and the other based on the region in which the activities or craft were primarily designed to operate. However, ultimately the problem seems to linger – whatever the technology, if the craft never *actually* goes to outer space or if the activity never *actually* takes place in outer space, what justification can there be for labeling it a spacecraft or space activity based solely on the technological specifications.

the functional equivalent of air travel and the vehicle the functional equivalent of an aircraft. Because the function of a craft cannot be determined without referencing its purpose, and its purpose cannot be determined without referencing the use its occupants or controllers are putting it to, functionalism may run into certain difficulties if a craft has contradictory purposes and uses on the same flight.

B. Establishing a Fixed Boundary[485]

Spatialists, believing "that there must logically be in law a clearly determined upper limit to national space and a clearly determined base-line marking the beginning of outer space,"[486] advocate establishing a fixed boundary which will delimit airspace from outer space. Although there is no agreement among spatialists regarding the precise location of a fixed boundary, they all do agree that a boundary is required.

1. Pros

One primary advantage of setting a fixed boundary between airspace and outer space is that it would bring an end to the legal uncertainty on the issue that has endured since the beginning of the space age.[487] Once a boundary is established, it will be easy to determine whether air law or space law is applicable in any given situation, and it will be easier to monitor compliance with the international laws applicable to one realm or the other.[488] A fixed boundary will also facilitate the development of laws relating to the emerging commercial spaceflight industry, including in important areas such as safety

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485 See Chapter II.C.2, above, for a further discussion of the spatialist views.

486 Cheng, *supra* note 209 at 600.

487 See generally Jasentuliyana, *supra* note 265 at 51 (noting the argument "that the question of delimitation is part of the more comprehensive legal question of the applicability of treaties, and that it is therefore necessary to have a conventionally defined boundary between airspace and outer space").

488 See generally Caesar Voûte, "Boundaries in Space" in Bhupendra Jasani, ed. *Peaceful and Non-Peaceful Uses of Space: Problems of Definition for the Prevention of an Arms Race* (NY: Taylor & Francis, 1991 for UN Institute for Disarmament Research) 19 at 21-23 (discussing the necessity of a fixed boundary with respect to any treaty addressing the prevention of an arms race in space); Gorove, *supra* note 373 at 274 (stating that "[f]or any meaningful arms control to apply to space, or more precisely 'outer space,' it is essential to know where its earthward boundary lies").

regulations and international standardization.[489] From a commercial standpoint, specifically with respect to the continuing growth of the industry, the certainty provided by a boundary, wherever it might be located, will be invaluable.[490]

Fixing a boundary is also supported by the existing body of international law, which undeniably recognizes that airspace and outer space are two separate realms, subject to two separate and distinctive sets of laws.[491] Based on these facts, the idea that a boundary exists becomes undisputable; the only question that remains is where that boundary is located. Whether the boundary is arbitrary, or based on certain factors or criteria, has no relevance; the fact is that a boundary must necessarily exist. Boundaries in law are often arbitrary and, perhaps just as often, based on certain factors or criteria which may or may not be external to the purpose of establishing the boundary.[492] Thus, just because there is no 'natural' criteria that can be used to point to an absolutely

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[489] See *e.g.* Cheng, *supra* note 209 at 647-48, stating that:

> The danger for them [commercial entities] of the major space powers wishing to keep all the options open by refusing to make clear where their territorial airspace, over which they have absolute control, ends, and where outer space, over which they legally have absolutely no such right, begins, lies in such powers abruptly deciding on an alternative option. One may suddenly fine one day that one's spacecraft is impounded or even destroyed for allegedly trespassing in some State's national airspace. Many a complete enterprise can be ruined simply because a major power has changed its mind about the height of its national airspace. This has happened before with maritime frontiers. *Certainty is essential.*

[Footnote emphasis added].

[490] *Ibid.*

[491] See generally Voûte, *supra* note 488 at 21 (noting that "[p]roponents of a definition/delimitation argue that the basic difference between the legal status of air space and outer space necessitates such a delimitation from a legal point of view. Otherwise the legal system would remain incomplete and in some respects ambivalent"); Cheng, *supra* note 209 at 393 (noting "it is clear that reckoning from the surface of the earth upwards, we have first a zone, the airspace, over which, if this zone is over the territory of a State, that State exercises complete and exclusive sovereignty, and beyond this zone outer space in which the exercise of such territorial sovereignty is precluded. How it can be argued that these two zones need not in law be clearly demarcated has always remained a great mystery to me"). See also Chapter II.B, above, discussing the differences between international air law and international space law.

[492] See generally Cheng, *supra* note 209 at 600-01 (noting that the functionalist "argument either betrays ignorance of for deliberately ignores what States have done for centuries in drawing invisible boundary lines on the sea which separate their territorial seas from the high seas, lines the precise location of which it is impossible to determine except through detailed maps of the coast and by reference to the legislation of the coastal States").

scientifically correct boundary location, does not mean that a legal boundary is inappropriate.[493]

Because the differences between air law and space law make it clear that the two realms are legally separate and that a boundary must exist, the fact that there have, to date, been no legal problems caused by the lack of a boundary is not a sufficient justification to avoid establishing a boundary. Rather than waiting for a legal difficulty to arise and then attempting to set a boundary, it would be more logical for the law to be anticipatory rather than reactionary.[494] The lack of a fixed boundary introduces ambiguity into all areas of international law that could potentially be affected by the location of the boundary.[495] Awareness of the ambiguity should be sufficient impetus to resolve the issue.

A fixed boundary also eliminates the problem of determining the function of a particular vehicle on a particular flight, or whether a given activity is functionally a space activity.[496] By fixing a boundary, it becomes possible to regulate based on the objective factor of location, rather than a more subjective determination of function.[497] When a

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493 See generally *ibid.* at 645 (discussing the generally territorial basis of the application of international law); *ibid* at 34 (noting that the concept of the continental shelf in the law of the sea "differs from its purely geological concept").

494 See *e.g. ibid* at 447 (likening the current approach and that favored by functionalists to "letting sleeping dogs lie and . . . even letting them have one free bite when they wake up," and further noting that "the geostationary orbit, remote sensing, and other factors would seem to suggest that in practice, especially when it is recognized that one will have to do it [set a boundary] in due course, it would be more prudent to try and slip the muzzle on the animal while all the issues are still dormant than to wait until the divergent interests of all the nations have hardened"); *ibid.* at 84 (noting that "unless the frontier is clearly delimited, conflicts of jurisdiction can easily and legitimately occur which at all times would be difficult to resolve and in times of international tension may quickly escalate into major crises").

495 See generally *ibid.* at 33 (noting that "any frontier which is not unequivocal is bound to be a source of controversy. The most urgent task in space law is, therefore, to secure a general agreement among States fixing the precise upper limit of national sovereignty").

496 See generally *ibid.* at 442 (stating that the functionalist approach would require "law to be individually tailored for each case. This is not law, but equity which . . . is justice (read alternatively policy) in the individual case").

497 See generally *ibid.* at 645 (stating that "insofar as international law is concerned, the initial and most fundamental level of classification is spatial . . . which precedes, and in fact determines, any functional classification when an activity is lawful or not lawful").

given craft is in outer space, it will be subject to space law. When it is in airspace, it will be subject to air law. The same will hold true for activities. The fact that setting a fixed boundary may result in a given craft being subjected to two separate bodies of law (both air law and space law) during one flight is not a cause for concern and, in actuality, is something that commonly occurs. For example, regardless of the type of vehicle in question, be it an airplane, car, ship or something else, when that vehicle crosses a national boundary from one State to another, or crosses from international territory into national territory, it becomes subject to the laws of the State it enters. It does not matter if the vehicle is only transiting through the State with no intention of stopping; by entering the territory of another State, any vehicle is then subject to the relevant laws of that State. In international transit, there is nothing at all unusual about a given vehicle being subjected to several different sets of laws during the course of its journey; in fact such a situation is the norm.[498]

2. Cons

A natural companion to a fixed boundary, at least in a legal sense, is the argument that the boundary was fixed in the wrong location. The functional approach will not disappear in the event a boundary is fixed; instead it will likely be used to attempt to justify moving the boundary to a more appropriate location whenever a new technology comes along that is arguably more 'aircraft' than 'spacecraft' or vice versa.[499] Such an argument could also come up in litigation, especially in cases where it would be more

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[498] See *e.g. Chicago Convention*, *supra* note 206 at art. 11. Article 11 States:

> Subject to the provisions of this Convention, *the laws and regulations of a contracting State* relating to the admission to or departure from its territory of aircraft engaged in international air navigation, or to the operation and navigation of such aircraft while within its territory, *shall be applied to the aircraft of all contracting States without distinction as to nationality, and shall be complied with by such aircraft upon entering or departing from or while within the territory of that State.*

[emphasis added].

[499] But see Cheng, *supra* note 209 at 437 (stating that "[c]ontrary to the view of some functionalists, spatialism does not mean doing away with a functional classification of what is a lawful activity and what is not, but to apply a functional test without regard to where an activity takes place is not only to put the cart before the horse, but to dispense with the horse").

advantageous to have the law of the other realm apply, which could ultimately lead, especially in the private law field, to varied national interpretations on the matter.

The question of where the boundary should be located, and what factors should ultimately determine that location, can be used to argue against fixing a boundary. Because there is no absolute, scientific point where airspace and outer space meet, a boundary would necessarily have to be based on some other criteria, or perhaps set arbitrarily. The history of the boundary debate demonstrates that for each criteria-based argument for a boundary location, there is a counterargument as to why that criteria is inappropriate or destined to lead to future problems. And, of course, any suggestion of an arbitrary boundary will be met with a demand for justification as to why that location is appropriate. Proponents of the functional approach also often point out that a boundary is not necessary because, to date, no problems have occurred due to the lack of a boundary.[500] In the end, the political debate that has endured for the last half century with no resolution in sight, may well continue for the foreseeable future with no agreement on where to establish a boundary (even if it was agreed that a boundary should be set), whereas the functional approach, being applicable only to objects and activities, and not having as great an effect on territorial sovereignty, might stand a better chance of passing through the political process that is international lawmaking.

A fixed boundary also leaves the question of access to space unanswered. If a boundary is established such that it is impossible for some States with limited territorial airspace to transit craft to and from outer space without violating the territorial airspace of neighboring States, such States could effectively be blocked from exercising their right of free access to space. It is unlikely that any boundary would be agreed upon in the absence of an associated agreement settling the question of access. Because any access agreement would necessarily seem to require a functional differentiation between the

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[500] See *e.g.* Jasentuliyana, *supra* note 265 at 51-52 (noting that the view of those on the functionalist side of the boundary debate in the COPUOS "is that the need for such a boundary has not yet been established, in the 40 years of the peaceful exploration and use of outer space there has never been a practical problem caused by the lack of a boundary between airspace and outer space, and that any attempt to establish such a boundary could cause more problems than it would solve").

spacecraft and objects that were allowed to take advantage of the right of access to space and the aircraft that were not permitted to take advantage of such a right. In that case it may be more efficient to institute a functional approach because a spatialist approach combined with a right of access/right of innocent passage for spacecraft through airspace would effectively produce results remarkably similar to the functionalist approach – aircraft would be limited to airspace and required to follow existing air law, while spacecraft would be subject to space law but permitted to freely use airspace without the restrictions of air law.

C. Chapter Summary

The debate between the functionalists and spatialists has existed ever since delimitation became an issue in international space law, essentially since the beginning of the space age. Because airspace and outer space are each governed by separate bodies of international law, there can be no doubt that each is an exclusive realm and, somewhere, there is a point where airspace ends and outer space begins. However, before the debate on where that demarcation point is can begin, the debate between the functionalist and spatialists on whether there is any need to define that point must come to an end.

Law does not exist separately from politics in any field, but international law is especially susceptible to the forces of international politics because, for the most part, international law will not come into being without the consent of those it acts upon, the States. The fact that the debate within the COPUOS has dragged on for half a century is ample evidence of the role played by politics. With a major space-power, the U.S., refusing to even discuss the issue, the possibility of progress is limited. At this point each side in the debate knows the arguments of the other, each knows its own strengths and weakness, and each knows the legal footing they are standing on from an international law perspective. What is lacking is the political will to come to a resolution. Unfortunately, at this point, it seems that only an event which forces the issue and somehow changes things so that the status quo is no longer a viable option will be sufficient to kick-start meaningful debate among States, whether it be inside the COPUOS or elsewhere.

CONCLUSION

Although the question of where airspace ends and outer space begins has been debated by international lawmakers for over half a century, it has not been treated as a fundamental legal issue in urgent need of a resolution. Instead the spatialists and functionalists have endlessly reiterated their respective positions, seeming content to engage in another fifty years of circular debate. However, while the delimitation arguments may be identical to those that were raised in the 1950s, technology has evolved and a 'new' space industry has emerged.

The lack of urgency in resolving the boundary issue stems largely from the perception that the delimitation of outer space is of limited relevance. Because no significant international legal difficulties have arisen due to the lack of a boundary, States have not treated the issue as one in actual *need* of resolution; perhaps not a surprising state of affairs as international lawmaking is often a more reactionary than anticipatory process. Unfortunately, while international lawmakers argue that the uncertain boundary has not created any legal problems, they are failing to recognize that the uncertainty itself is a legal problem for commercial space industries; the lack of legal certainty represents an unknown quantity, an added business risk in an already inherently risky field.

Lawmakers are undoubtedly aware of the potential legal difficulties, such as the scope of application of both air and space law, created by an undefined boundary. Many legal definitions in the air and space law fields are directly linked to physical presence in either airspace or outer space. In a time when the space industry was government-dominated, perhaps the argument that potential difficulties and unclear definitions were unimportant problems could be justified as States could take care of such issues through diplomatic means or other high-level channels. That time, however, has passed. The legal concerns of the commercial space industry do not necessarily mirror those of a state-based space industry. The development of the private space industry, new technologies, and optimal commercial growth cannot take place within a sphere of legal uncertainty. After fifty years of discussion and debate, it is time international lawmakers recognize the boundary issue is a fundamental legal question in need of resolution.

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