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National Space Forum 2007: Towards a Theory of Spacepower

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The Spacepower Theory Project seeks to gain insight into human behavior in outer space. The project's overall objective is to develop a theoretical framework that helps to define, categorize, explain and anticipate ways in which "spacepower" may be pursued, how the various facets of spacepower connect to each other, and how they relate to the other instrumentalities of power that state and non-state actors may seek to achieve or retain.

Since 1957, spacepower has evolved from the first space age, where prestige was a primary motivation of activity, to the second (current) space age where the primary commodity of space is information. The next space age may well be defined by the creation of wealth in space and other celestial bodies. Throughout these phases, outer space activities provide a means for enhancing sociocultural, economic, and political power.

To reach the potential promise of space in these areas requires serious attention to the security aspects of the space domain. Security in space could be maximized by a situation in which unfettered access by spacefaring actors becomes a norm for amicable interstate relations; where such actors achieve a measure of protection against the aggressive or capricious acts of spoilers; and where real or perceived vulnerabilities among space actors are minimized. Creating a condition of enduring stability in outer space will depend upon how tensions between national interests are addressed and whether there emerges over time a convergent perception of what actions tend, on balance, to strengthen or undermine stability.

The National Defense University's Institute for National Strategic Studies (INSS) is conducting a study that seeks to develop a theory of spacepower– that is, a conceptual framework for explicating the fundamental aspects of spacepower and its relation to the pursuit of national security, economic, informational, and scientific objectives in a fashion that provides insight into the behavior of spacefaring actors. The project takes into account the views and perspectives of the principal users of space, and it attempts to assess the underlying assumptions regarding why and how a society, a nation, or a non-state actor might use space– either alone or, more likely, in tandem with other means– to accomplish specific ends. The resultant theory will provide policy specialists and space professionals from any nation– whether in the national security, civil, or commercial space sectors– with an intellectual foundation upon which to assess the conduct and impact of space-related activities. This paper outlines initial insights generated by the project and serves as a vehicle for eliciting feedback from United States (U.S.) and international stakeholders.

Through a series of seminars, workshops, and conferences, which includes a National Space Forum on the topic held in 2007 that was sponsored by INSS and the Eisenhower Center for Spacer and Defense Studies at the U.S. Air Force Academy, experts in the global space community provided and exchanged a rich set of viewpoints, ideas, and theories in an ongoing dialogue. Additionally, the Spacepower Theory Project team traveled to Japan, China, and India to capture views in a region of burgeoning space competition. The insights in this update will be

refined into a concise monograph for distribution among the space and policy communities.

Additionally, the project team is in the final editing stages of a book length manuscript that was discussed at the National Space Forum mentioned above. The book contains thirty chapters, which are listed below, by various expert authors commissioned for this project. This book will be published by National Defense University Press (or a commercial press) in 2008.

1. Implications of Spacepower for Geopolitics
2. Introduction to Spacepower Theory
3. On the Nature of Theory
4. International Relations Theory and Spacepower
5. Old Thoughts, New Problems: Mahan and the Conception of Spacepower
6. Airpower, Cyberpower, and Spacepower
7. Orbital Terrain and Space Physics
8. Space Law and Governance Structures
9. Building on Previous Spacepower Theory
10. History of Commercial Space Activity and Spacepower
11. Commercial Space Industry and Markets
12. Merchants and Guardians
13. Innovative Approaches to Commercial Space
14. History of Civil Space Activity and Spacepower
15. Affordable and Responsive Space Systems
16. Competing Visions for Exploration
17. Spacepower and the Environment
18. History of Security Space Activity and Spacepower
19. Increasing the Military Uses of Space
20. Preserving Freedom of Action in Space
21. Balancing Security Interests
22. Russia
23. China
24. Europe
25. Emerging Actors
26. Evolving United States Structures
27. U.S. Military Power: Conceptual Underpinnings and Practice
28. Technological Drivers
29. Building Human Capital for Spacepower
30. The Future of Spacepower

These works can only begin to capture a fraction of the thinking in the space community today and should be considered snapshots of progress towards developing a theory. This will not be a definitive work; the theory should be a living document that continues to evolve and progress with the human experience of space. Ultimately, this project is less about space itself, but rather about human, state, and societal behavior and their relationships to the space domain.

Developing a Theory of Spacepower

The overarching scope and definition of this spacepower theory requires a strategic perspective that transcends purely military, economic, political, or nationalistic perspectives. This theory strives to do the following things:

- *Define* what spacepower is, what it is not, and what makes it unique in order to provide a common lexicon for all space actors.
- *Categorize* the elements, constituent parts, and factors that yield a framework for thinking about spacepower.
- *Explain* the ways in which spacepower has exhibited during its short history.
- *Connect* elements within spacepower and to other means of national power.
- *Anticipate* potential ways in which spacepower might be used in the future.

A theory of spacepower should not be confused with a policy, strategy, or doctrine, though it may inform such efforts. Although written primarily from the perspective of the U.S., it is not intended to suggest specific courses of action for the U.S. or any other specific actor. The basic principles of the theory should be applicable across a broad range of space actors.

The development of spacepower theory can be related to the development of sea power theory by Alfred T. Mahan in his work *The Influence of Sea Power Upon History, 1660-1783.*[1] Mahan addressed the importance of economic trade to the

[1]A. T. Mahan, *The Influence of Sea Power Upon History, 1660-1783,* 14th ed., (Boston: Little, Brown, and Company, 1898).

prosperity of the American nation and the implications for maritime and naval activity in the advancement of this prosperity. He addressed the essence of sea power primarily through a historical lens by looking at the nature of the maritime activity of great powers in history. Writing from the perspective of what could be considered a second-tier naval power at the time, i.e., the U.S.; he drew important lessons for creating American economic strength by advancing its attention to sea power. A "Mahanian theory" for spacepower should consider the role of space activity in relation to the larger strategic and international environment.

Spacepower theory, it should be stressed, is not a military theory. It is a strategic theory based upon human activity as applied to the space domain. Although the historical evidence for space activity is limited, theorizing about human behavior in a variety of disciplines provides a sufficient base upon which to draw. Theories of science, philosophy, human nature, politics, economics, and geopolitics have been incorporated in addition to theories of war and other military theories.

A Short History of Spacepower

Since the launch of Sputnik in 1957, the world has seen two identifiable space "ages," each distinct in its significance and influence on human affairs. A much longer pre-space age saw technological advancements enable the fulfillment of once fanciful visions of space travel and exploration. This rich history of space offer signposts that point to potential space ages of the future.

The first space age, from 1957 to 1991, is often associated with the shorthand term "the space race." Space activity became a microcosm of the global geostrategic environment that defined the era. The imperatives of the bi-polar Cold War accelerated the advancement of space technology and activities in space. For both the Soviet Union and the U.S., this competition played out in several important ways:

- A geostrategic competition to showcase technological, economic, and military power.
- A public civil competition to explore near-earth space and ultimately the Moon.
- A (largely) hidden military and intelligence competition for strategic advantage.
- A slowly developing economic enterprise.

The primary commodity of the first space age was prestige. Both the Soviet Union and the U.S. viewed their space programs through the larger geostrategic competition. The prestige associated with the civil space programs afforded a new type of moral power to both nations as they vied to establish dominance of their cultural, political, and economic systems.

Just as the Cold War was the defining context for the first space age, the fall of the Soviet Union and an era of U.S. unipolarity defined the second or "American space age." This space age continues to be the dominant feature of the current space environment. This shift was exemplified by the 1991 Gulf War, sometimes referred to as the "first space war." The predominant features of this space age include:

- The rise of globalization, with greatly increased communications and information flows, enabled by the global perspective of satellite technology.
- A shift in military emphasis from gaining strategic advantage in space to gaining operational and tactical advantage in terrestrial warfare.
- A precipitous decline in the former emphasis on civil space.

The primary commodity of the second space age has been information. While some new players entered the space arena to enhance their prestige, advanced spacefaring actors developed and used space to enable the transition into the "information age." Today's emphasis on information in space has greatly enhanced the military, economic, and political power of those actors, with the U.S. as the dominant power in the space-enabled information area.

It is unclear what the dominant features of the next space age will be or when it will definitively

occur. Shifting features in the geopolitical context suggest that the shift to the next space age will occur within the scope of this theory (i.e., within the next 50 years). These features (to be explored in more detail in an additional section in the final report of this project) include a shift away from the unipolarity of today's international system to a multipolar environment with a much broader and more diverse set of actors. As power is diffused among these actors, the nature of power in space will begin to change. Potential features of the next space age might include:

- Great technological advancements which significantly lower the barriers to entry for potential spacefaring actors.
- Shift from a geocentric perspective to a solar system perspective.
- Renewed strategic competition in space.

A primary commodity of the next space age may well be wealth. The dominant paradigm in space could become an economic one, as activities in space shift from enabling wealth creation on Earth to that of wealth creation in space. The economic value of space is currently but a small fraction of its potential. Beyond the impact space has in supporting earthly economic enterprises, the next space age will be marked by a boom in the economic value of space itself. Alvin and Heidi Toffler have suggested that the development of wealth creation in space would be revolutionary and signify a "fourth wave" of human development.[2]

A brief look at the history of space activity suggests that humans go to space for a variety of reasons: geopolitical, military, economic, scientific, and human destiny. Regardless of the reasons for going to space, such activity conveys a variety of benefits to spacefaring actors: prestige; military advantage; economic competitiveness; and scientific prowess. Benefits accrued to the larger society have included: the advancement of scientific knowledge; stimulation of global economic activity; enhanced communications and information flows; and awareness of the global environment.

[2]Alvin and Heidi Toffler, *Revolutionary Wealth* (New York: Alred A. Knopf, 2006).

The Nature of Spacepower

Power is perhaps the most important yet ill-defined concept in the study of politics and international relations. Power is often associated with the specific instrument through which it is manifested such as economic, diplomatic, informational, economic, or military power. Major dimensions of power focus on how it is created, increased, decreased, stored, communicated, used, and measured. A key consideration is whether power is fungible, or easily transferable, between dissimilar instruments such as diplomatic and military power. Most dimensions of politics and international relations revolve around how states and other actors use power.

This study builds from Joseph Nye's simple definition of power as "the ability to achieve one's purposes or goals."[3] It is therefore a natural extrapolation to define spacepower as "the ability to use space to achieve one's purposes or goals." In a further expansion of the definition of power, Nye suggests that it is the ability to influence others that creates this power. While that is true for spacepower, space capabilities may also be able to influence natural events as well as human behavior. An expanded definition of spacepower could then be derived as "the ability to use space to influence others, events, or the environment to achieve one's purposes or goals."

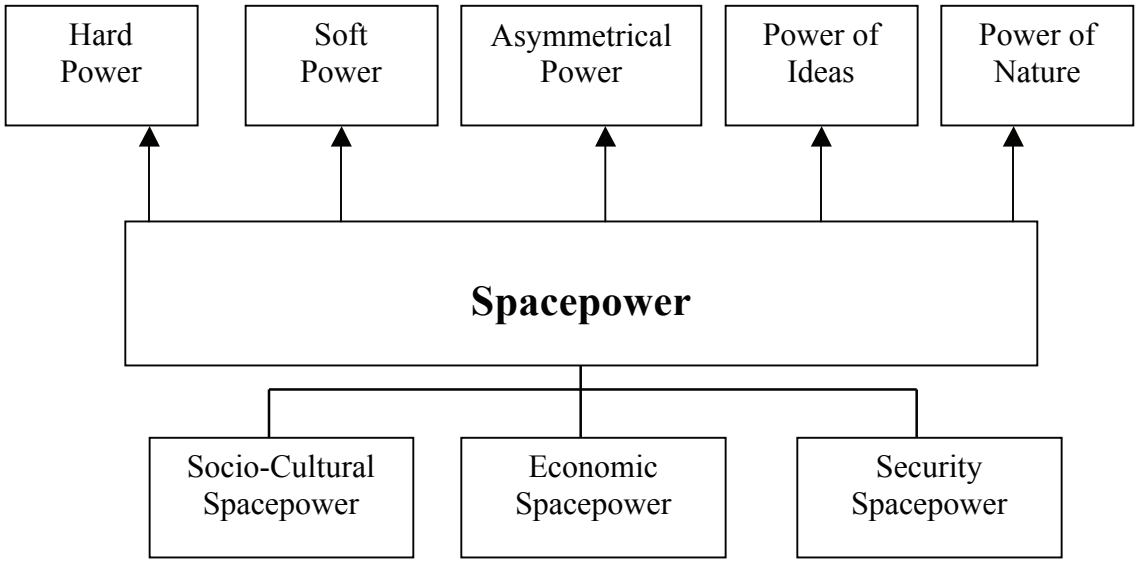
In an increasingly complex and globalizing society, there are five important types of power:[4]

[3]Joseph S. Nye, Jr., *Understanding International Conflicts: An Introduction to Theory and History* (New York: Pearson-Longman, 2005).

[4]See Sean Kay, *Global Security in the Twenty-First Century,* (Lanham, MD: Rowman and Littlefield, 2006). Kay identifies these as state power; soft power; asymmetrical power; people, ideas, and information power; and the power of nature.

- **Hard power.** The classic application of power by state actors consists of the ability to use inducements or coercion through military, economic, or diplomatic applications. Spacepower contributes to an actor's hard power by providing military and intelligence capabilities to threaten an adversary's terrestrial or space-based activities.
- **Soft power.** This concerns the overall attractiveness of an actor to others to attain its goals without threats or use of force. This "attractive power" is attained by setting the example and getting others to emulate favorable behavior. Spacepower provides prestige, technical and educational prowess, economic incentives, and cooperative ventures as means for enhancing soft power.
- **Asymmetrical power.** The acceleration of globalization has created a diffusion of power that allows weak actors to challenge strong or dominate actors in asymmetric ways. Spacepower tends to be dominated by stronger actors, but can be threatened asymmetrically by weaker actors through means such as kinetic anti-satellite weapons (ASATs), jamming, or attacks on ground facilities.
- **Power of ideas.** The diffusion of power from states down to the individual has occurred through the ubiquitous availability of information and ideas. Such power can either weaken or strengthen a state, society, or political system depending on the context. Spacepower plays a great role in the transmission of this type of power through communication, remote sensing, and navigation applications.
- **Power of nature.** Nature itself wields power that can present security challenges. The power of humankind to mitigate or avoid the ravages due to natural disasters, pandemics, climate change, or collision by near-Earth objects is enhanced by spacepower capabilities.

Spacepower contributes to all of these forms of power, including sociocultural power, economic power, and security power (see Figure below).



Definitions

Developing and applying a comprehensive and consistent set of definitions and categories are essential steps towards building spacepower theory. In addition to the discussion of power and spacepower above, key terms for this study include:

- **Space.** There is no universally accepted definition of space or outer space. Disputes

over sovereignty, the inability to precisely describe a spatial demarcation, need to distinguish from laws regarding airspace and other legal issues have stymied the development of an accepted definition. There has been a sort customary law that has developed to the effect that any object in orbit is considered to be in space.[5] For the purposes of this study space begins when objects are able to achieve positions in stable orbits around the Earth or beyond. With current technology, this would describe space as beginning at an altitude of approximately 69 miles (and above the accepted end of aerodynamic limits, the von Karman jurisdiction line, which is approximately 55-62 miles in altitude).

Astrographic. Everett Dolman provides a useful astrographic delineation of space into four regions: (1) terra (Earth and space to a point just below sustained, unpowered orbit); (2) terran space (lowest viable orbit to just beyond geostationary altitude); (3) lunar space (just beyond geostationary orbit to just beyond lunar orbit); and (4) solar space (everything else in the solar system).[6]

- **Spacefaring.** Spacefaring is "the ability to do something in space." Spacefaring activities are "activities conducted in space." Spacefaring actors are "state and non-state actors engaged in spacefaring." Spacefaring actors conduct spacefaring activities through indigenous production, collaborative efforts, or third party purchase of space systems or services.
- **Space Industrial Base.** The space industrial base includes "those elements of industry and education that contribute to spacefaring."

Shaping Factors

An actor's spacepower capability is shaped by in variety of ways. The physical nature of the domain both constrains and enables human ability to utilize space for specific applications. Technology is used to overcome these limitations but is itself constrained by costs and the state of scientific development. The appropriate resources to include wealth, access to materials, and industrial capacity are essential. The political and cultural environments within and among nations also determine the level of interest and motivations for developing space programs. Finally, governance issues, particularly with regard to international laws and regimes, play a role in determining the path of spacepower. In considering these shaping factors, some implications can be derived:

Spacepower is unique because it can operate both in relation to earth activity and independent of it.

- Certain physical phenomena in space (e.g., gravity wells, libration points, predictable Earth orbits) can provide strategic advantage (and disadvantage) to space powers.
- Technology eventually lowers costs.
- Space technology can be single or multi-use.
- Maintaining the space infrastructure and an industrial base is not a free good.
- Political will is required for the long haul.
- Non-state actors may be hampered by domestic regulations, laws, and political constraints.
- A spacefaring culture includes both technical prowess and ambition.

Forms of Spacepower

Almost all space activities can normally be placed into just one of the following sectors: civil, commercial, military, or intelligence activities. However, growth in commercial space activity, the increasing number of dual-use space systems, and digital convergence can also make it increasingly difficult to categorize certain space activities neatly into one of these sectors. Many spacefaring actors have separate government organizations dedicated primarily to performing only the activities within one of these sectors. For the purposes of this study, the military and

[5]Glen H. Reynolds and Robert P. Merges, *Outer Space: Problems of Law and Policy,* (Boulder, CO: Westview Press, 1998).

[6]Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, (London: Frank Cass Publishers, 2002).

intelligence activities will be considered as a single sector, the national security space sector.

Spacefaring actors include those operating at the surprastate, transnational, state, and substate levels. This raises a "levels of analysis" problem that makes consistent categorization and comparisons difficult. By considering an actor's level of activity across the three spacepower sectors described in the previous section, a set of archetype space actors can be fairly described as follows:

- Comprehensive space powers have robust, indigenous space capabilities that provide significant benefits through space operations in all space activity sectors: commercial, civil, and security. They have indigenous capacity to manufacture, launch, and operate space systems.
- Emerging space powers are those actors actively developing their capabilities in all three sectors of space activity. They may still be developing capacity in certain areas, but are progressing toward comprehensive capability.
- Niche spacefaring actors have chosen not to develop comprehensive space capabilities or do not (yet) have the intent or resources or required to develop such capabilities.
- Consortia, such as the European Space Agency (ESA) or the partners in the ongoing International Space Station (ISS) effort undertake many space activities.
- Space entrepreneurs are pursuing a range of new private space ventures such as space tourism or space mining activity.
- Free riders are space beneficiaries that use at least some product or service created by spacefaring activity. Due to growth in the efficacy and ubiquity of spacefaring activity, these space beneficiaries comprise a very broad category that includes nearly every actor in the modern world.

In describing spacepower, the unique aspects of space as an operating environment and of spacefaring activity as a set of human endeavors are evident. A few insights from this section include:

- Metaphors from other domains, sea, air, and land, do not necessarily apply.
- Perspectives and motivations vary among actors, categories of actors, and among sectors. Consider the primary drivers in each of the space sectors: civil space as destiny and discovery driven; commercial space that is profit driven; and security space, which is threat driven.
- Harmonization among space actors, categories of actors, and among sectors is difficult to achieve.

Spacepower and the International System

Spacepower has an emerging role in the international political system, and at the same time the nature of that system influences how actors might perceive and use spacepower. Spacepower to date was shaped primarily by the Cold War context in which it matured. As the international system exhibits changes over the next fifty years, the nature of spacepower can be expected to change with it.

Realist and Liberal Perspectives

Associating the word power with space activity connotes in many a realist interpretation of human behavior, yet both the realist and liberal perspectives are present in those advocating and developing spacepower strategies. It is useful to consider varying assumptions that might affect an actor's notion about the role of spacepower in the international system. The table below briefly highlights some of these assumptions and prescriptions generally associated with traditional realist and liberal perspectives.[7]

[7]This chart was derived from a number of sources. See John J. Mearsheimer, *The Tragedy of Great Power Politics,* (New York: W.W. Norton, 2001); Joseph S. Nye, Jr., *Understanding International Conflicts: An Introduction to Theory and History* (New York: Pearson-Longman, 2005); Hans Binnendijk and Richard Kugler, *Seeing the*

While certainly there are more complex explanations of the international system, this simplistic look at the two major perspectives goes a long way to understanding the tension points in many spacepower debates. The realist would tend to view space as another domain for great power competition, and ultimately conflict. The liberal view in its most progressive form sees space as a venue for the evolution of the human species to a higher order destiny; but at a minimum holds that maintaining space as a sanctuary provides the best guarantee of stability in space.

	Realism	**Liberalism**
Assumptions about human behavior:	Pessimistic	Optimistic
Unit of analysis:	Individual states	International system
Principal actors in international system:	States exclusively; great power states primarily	States primarily, but increasingly diverse set of supra- and sub-national actors
State behavior determined by:	External power calculations	Internal characteristics
Modern world affairs driven mainly by:	Security competition	Democratization and economic growth
The main goals of foreign policy should be:	Increasing power to guarantee security and survival	Democracy and economic growth
The primary instrument is:	Hard power	Soft power
Concerned with:	Relative gain (zero-sum)	Absolute gain (mutual benefits)
International system should be optimized to provide:	Security	Stability
Treaties, alliances, and international institutions merit:	Less faith	Strong support
Interdependence creates:	Vulnerabilities	Opportunities for cooperation
Best chances of success in world affairs comes from:	Benign hegemony by a great power acting as a Leviathan	Liberal democracies working together multilaterally

Elephant: The U.S. Role in Global Security, (Washington, DC: Potomac Books, 2006); and Sean Kay, *Global Security in the Twenty-First Century,* (Lanham, MD: Rowman and Littlefield, 2006).

These competing viewpoints vie for influence in the decision processes of spacepower actors. Applying the realist and liberal lenses to spacepower yields the following insights shown in the next table.

	Realism	Liberalism
Human behavior in space:	Will mirror human behavior on Earth	Can transcend terrestrial disputes
Principal actors in space:	Spacefaring states	Spacefaring states; consortia; non-state entities; private enterprise
State behavior in space determined by:	Power calculations	Domestic goals and needs
Spacepower optimized for:	Security	Stability
Spacepower is maximized through:	Space dominance	Space as a sanctuary
Space as a venue is inherently:	Competitive	Cooperative
Rules sets should guarantee:	Freedom of access	Common heritage of mankind; peaceful uses of outer space
Means to achieve:	Space control	Legal frameworks
Interdependence in space creates:	Vulnerabilities; cascading effects	Opportunities for cooperation; stability

The Current Paradigm of Spacepower in the International System

The 1967 Outer Space Treaty defined the initial principles for space activity and these principles describe the dominant paradigm of the international community regarding spacepower:[8]

- Space is the province of all mankind– a "global commons."
- Space is to be used for peaceful purposes.
- All states have an equal right to explore and use space.
- International cooperation and consultation are essential.
- Signatories retain ownership of their space objects and bear responsibility for their space activities, including and damage inflicted on another state's space objects.

Although most, if not all, spacefaring actors ascribe to the principles of the Outer Space Treaty, a number of issues have arisen to challenge the dominant paradigm:

- **Definitional problems.** The terms "peaceful uses" and "common heritage of mankind" have widely varying interpretations among space actors.
- **Sovereignty and property rights.** Economic development in space under the current paradigm is stunted by lack of legal definition concerning these issues.
- **Prospects of weapons in space.** Concerns over possible deployments of ASATs and space-based missile defense systems present serious problems for those desiring space to retain a "weapons-free" status.
- **Pursuit of self-interests.** As more actors enter into the space domain, there may be a growing

[8] *Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies*. Done at Washington, London, and Moscow 27 January 1967; entered into force October 10, 1967.

tendency to pursue unilateral interests rather than adhere to established norms.

International Security in Space

The space political environment is still in its infancy, and it is unclear how the balance between purely national and global interests will be managed. A reframing of the current paradigm may be required to accommodate the changing nature of space activity. States will likely seek alternative arrangements in space as they perceive greater security vulnerability. Some alternative ways that states may choose to enhance security or stability, either individually or collectively, include:

- Pursue unilateral strategies.
- Apply a balance of power approach.
- Develop alliance-based security arrangements.
- Establish "rules of the road."
- Establish frameworks for cooperation and interdependence in space.
- Negotiate arms control or other legal restraints.

From the standpoint of international security, one can identify an optimal condition of enduring stability in the space domain. Its attributes would include:

- A norm of unfettered access to space as a feature of amicable inter-state relations.
- A solid measure of protection, through individual or collective measures, against the aggressive or capricious acts of spoilers.
- A situation in which the real or perceived vulnerabilities among space actors are minimized.

Ultimately, creating a condition of enduring stability in outer space will hinge upon how tensions between national interests are addressed and whether there emerges over time a convergent perception of what actions tend, on balance, to strengthen or undermine stability. If enduring stability is not the primary goal of major space powers, then the prospects for military competition and conflict will increase.

Enhancing the International System

In a stable environment, space can enhance and strengthen the international system. The economic and sociocultural imperatives discussed earlier suggest the importance of maintaining space as a domain for wealth creation and for solving problems of humankind. Spacefaring actors should consider adopting cooperative approaches in space to address some of issues of global concern:

- Energy scarcity.
- Global climate change.
- Space situational awareness.
- Space debris.
- Defense against Earth colliding objects.
- Material resource scarcity.
- Extra-terrestrial property regimes.

The ability to forge collective action on these and other issues will enhance understanding, confidence building, and sharing of knowledge that will contribute to the stability of space as a regime and to its effectiveness in enhancing human prosperity.

Sociocultural Spacepower

Space has been described as a "global commons," a term which suggests a medium or domain that exists for the common good of all. Global commons are "natural assets outside national jurisdiction, such as the oceans, outer space, and the Antarctic."[9] There is no international standard as to what constitutes a global commons, and consideration of such varies widely. In addition to the oceans, outer space, and the Antarctic, some areas that are considered include: the atmosphere, telecommunications (electromagnetic spectrum), information, culture, and the environment. The idea that space would remain a province for cooperation is based on two interrelated principles that have been established as international norms:

[9] *Glossary of Environment Statistics, Studies in Methods*, Series F, No. 67, (New York: United Nations, 1997), stats.oecd.org/glossary/detail.asp?ID=1120 (accessed 4 August 2007).

(1) the peaceful purposes of outer space; and (2) the "common heritage of mankind" (CHM). The terms "peaceful purposes" and "common heritage of mankind" set forth social expectations that space should be used for the common good.

The public persona that satisfies these socio-cultural expectations can be found in the civil space activities of space exploration and space sciences. For current and emerging space superpowers, its "space program" in the public eye will be synonymous with its ability to explore beyond the Earth and unlock the secrets of the universe. Such a capability proves a state's technological prowess and single-minded ability to achieve its lofty goals. Indeed, becoming a space superpower is about vying for superpower status on the larger stage. Two general principles can be derived from the limited history of civil space activities:

- Prestige is the primary motivation for developing a civil space program.
- Spacefaring societies seek to extend their cultural values into space.

Civil space activities can be categorized into four main areas of current or future emphasis: (1) space exploration; (2) space science; (3) environmental security (both Earth and space environments); and (4) human habitation. In looking at these areas, the following can be derived:

- Space exploration attracts states and societies that have expansionist traditions, expansionist aspirations or both.
- Space science is a strategic asset in that it ensures technological independence cultural identity, supports a science-based society, and demonstrates capability and vision.
- Space provides an opportunity to solve common global problems through common global solution.
- Space settlements may one day be the key to the survival of the species.

Civil space activities must balance supporting national interests while advancing global interests. Of all the sectors, civil space activities are most likely to be cooperative in nature to achieve the goals of such programs, yet the programs themselves are subordinate to an actor's broader goals.

Economic Spacepower

Spacepower both influences and is influenced by an actor's economic power. Space applications have enabled globalization, created opportunities for development, and enhanced the global nature of the economy. In its current state, spacepower enables other economic enterprises. The potential for creating wealth from space suggests the likelihood of expanding development and economic competition at some point in the future. The point at which that potential is realized is greatly dependent on the factors that shape spacepower.

Spacepower has been a major, if often underappreciated, factor in enabling the globalization trend of the last twenty years. The explosion in communication and information technology was made possible through the global view of Earth-orbiting satellites. For developing areas of the world, space assets offer ways to better manage natural resources and extend services to remote populations. Additionally, space applications have played a major role in economic development.

- Telecommunications from space can be used to collect or distribute information from dispersed territorial entities.
- Space-based navigation facilitates the management of global fleets enabling the rapid movement of goods world-wide.
- Earth observation and remote sensing play a role in the design and implementation of new land infrastructure, the management of crops and natural resources, the enforcement of agricultural policy and environmental treaties, and the mitigation of natural disasters.
- Meteorological satellites greatly improve forecasting and monitoring of extreme weather conditions and the ability to mitigate their effects.

The Commercial Space Industry

The commercial space industry includes both an upstream segment, which includes manufacturers of space hardware and providers of launch services, and a downstream segment of satellite operators and providers of space-enabled products and services. Currently, the commercial space industry is focused almost exclusively from Earth-orbiting applications. The key characteristics of space-based activities that bear on the commercial space industry include: high risk; high-cost research and development; complexity of new technologies; economies of scope; dual-use nature of the technology; long gestation and durability of space assets; long value-added chain; and economies of scale downstream.[10]

The current economic paradigm is to use satellite technology to create wealth from space. Space service include: satellite telecommunications; satellite subscription and retail services; interactive broadband; global positioning, navigation, and timing (PNT); and commercial Earth observation.

The future economic paradigm will be to create wealth in space. Additionally, economic enterprises will not be limited to Earth's orbital plane. Eventually, wealth creation will occur on other planets and celestial bodies as well as in deep space. The timing of such activity is again dependent on the set of interrelated shaping factors. Some of the applications likely to create wealth in space over the next fifty years include: space tourism and adventure (orbital and sub-orbital flights); in-orbit servicing; space manufacturing (e.g., pharmaceutical products and new materials developed in microgravity); energy from space. (e.g., space based solar power systems to provide Energy to Earth.); and extraterrestrial mining. (e.g., mines on the Moon to harvest Helium-3 or mining near Earth objects for minerals). The ability to develop these markets depends requires:

- Significantly reduced access costs.
- Favorable economic environment.
- Safety and security of space assets and humans in space.

A robust and vibrant space economy is highly dependent on a number of factors. A review of those factors yields the following insights:

- The economic paradigm will eventually shift from creating wealth from space to creating wealth in space. New markets will develop that could radically alter the outlook for economic development in space.
- Technology is the most significant factor shaping the commercial space industry. Radical technological improvements, particularly in space access, will produce profound changes in what can or cannot be accomplished in space.
- The high costs of current space activity require heavy research and development efforts and assumption of risks beyond the scope of most space entrepreneurs. Sustained involvement of governments will be required to mitigate this risk in the near term.
- From an economic perspective, space should be a domain free to the pursuit of economic goals. The economic "global commons" approach is viewed differently from the sociocultural context that suggests all development benefits should be shared.
- Stability of the space-enabled information infrastructure is essential to continued global economic growth and vitality. Conflict, or the threat of conflict, would have serious effects on information flows vital to the global economy.

Security Spacepower

Notions of security in space (and through space) vary markedly based on the perspectives of diverse actors, a broad range of challenges and threats, and the nature of various space activities themselves. Space activities enable economic

[10]Organization for Economic Co-Operation and Development (OECD), *Space 2030: Exploring the Future of Space Applications,* (Paris: OECD, 2004).

security by enhancing the value of global economic interdependency, while reducing the vulnerabilities of singular actors. Human security can be advanced through such activities as: space-based telemedicine; infectious disease control; and enabling expansion of economic development in rural areas or those areas previously inaccessible to basic services. Environmental security can be enhanced through global monitoring of the Earth and solar system. Energy security may be achieved by those that are able to tap into a potentially unlimited source of solar and other forms of power in space.

While space has a role in each of these security areas, spacepower is often thought of in the context of national security as it enhances the ability of spacefaring nations to compete and thrive in an anarchic international security environment. The use of the terms "power" and "spacepower" are most closely associated with the notion of power as accorded to the state. While there clearly are many other forms of power wielded by many different types of actors in and through space, this project assumes that the state will remain the dominant form of power broker for the foreseeable future. Thus, it is important to consider the how spacepower relates to national security.

States and other actors tend to focus on pursuing their own interests. Space capabilities enhance the ability of an actor to gain economic, political, or military power relative to those that do not possess spacepower. Space confers strategic, operational, and tactical advantages because it provides a global view of the terrestrial environment in which competition and conflict currently takes place. In the future, space actors may seek to control key "geographic" regions of space (e.g., libration points, lunar antipodal points, preferred earth/lunar orbits) to gain strategic advantage for exploiting resources or establishing space lines of communication.

Depending upon how it perceives its national interests, a space power may pursue security in several basic ways: it may seek to maintain a favorable status quo; it may seek to expand its power to increase or close a perceived gap relative to other space powers; or it may seek to limit or constrain the power of other space actors. A spacefaring state will have two main concerns with regard to security and its space capabilities: (1) how to use space capabilities to provide for, support, and enhance the overall security of the state or related actors (security through space); and (2) maintaining the security of space capabilities themselves, both military and non-military (security in space).

Space is an operationally distinct medium. Spacepower, however, is not strategically distinct; it is part and parcel of an actor's ability to influence human (and perhaps natural) events regardless of where they occur. Spacepower may provide strategic advantage on earth or in space.

Security through space implies the use of space assets to enhance the security posture of an actor or set of actors on Earth. Space capabilities may be used by an actor to prevent conflict and ensure stability through:

- **Transparency.** The ability to "see" capabilities as they are developed and events as they unfold reduces uncertainty and provides strategic warning.
- **Deterrence.** The space-based reconnaissance complex plays an important role in providing warning as well as command and control for nuclear forces.

Conversely, a state may use its space assets to enhance terrestrial warfighting capability through:

- **Force enhancement.** Space forces greatly enhance the capability of air, land, and sea forces through PNT, command and control, and intelligence, surveillance, and reconnaissance (ISR).
- **Force application.** In the future, actors may develop ways to apply force directly from space to generate combat effects on the terrestrial battlefield. Defenses may also be deployed in space to deter and protect against ballistic missile attacks.

Security in space concerns the protection of space assets themselves, whether used for military or civilian purposes. States, particularly those with strategic advantage, will seek to maximize their freedom of action in space. In order to do so, an actor may seek capabilities in the following areas:

Transparency. Space situational awareness (SSA) is essential to identifying potential threats in space. Equally important is transparency over potential adversaries ground based activity as it relates to space.

Protection. The fragile and vulnerable nature of space assets, particularly commercial and civil assets, suggests that protection measures be considered early in the design cycle of space systems. Military forces may be called upon to protect civilian assets.

- **Denial.** The ability to negate adversary space capabilities, through such means as ASAT programs, may permanently or temporarily shift advantage in space.
- **Space control.** Space control is a combination of protection and denial strategies. An actor desiring freedom of action in space may also wish to limit its adversary's freedom of action to remove a perceived threat. This requires maximizing both protection and negation capabilities (e.g., defensive and offensive counterspace).

A number of security challenges and dilemmas arise as actors pursue individual interests in space:

- **Space assets are fragile and vulnerable.** Should space become a contested environment? The fragility and vulnerability of space systems make them attractive targets and complicates the ability to defend in space.
- **The lines between civilian and military space assets become blurred.** Systems deployed in space have the ability to be used for more than one purpose. Commercial communications satellites carry a large portion of military communications and can become vulnerable to attack in a conflict scenario.
- **Capabilities designed to enhance security through space may reduce security in space, and vice versa.** For example, space-based missile defenses may enhance protection against ballistic missiles, but they themselves become a strategic target and open the possibility for conflict in space.
- **Achieving the economic and sociocultural potential of space requires enduring stability in the domain.** Individual or unilateral strategies to expand power, limit adversaries' power, or maintain freedom of action in space may threaten overall stability of the system.

Spacefaring states will pursue security strategies in space based on their degree of reliance on space capabilities, perceived vulnerabilities both in and from space, and the perceived behavior of other actors. The following behavioral models may be observed as actors seek to meet their security needs in space:

- **Space dominator.** A domination strategy can only be attempted by a comprehensive spacepower with a highly advance military capability. A space dominator is likely to be highly reliant on spacepower to achieve its objectives in both in space and on Earth, and at the same time may feel a certain amount of insecurity due to the vulnerability and fragility of its space assets. Such a strategy would seek to increase its relative power vis-à-vis other space actors to enable freedom of action to pursue its interests in and through space. The dominator sees space as the ultimate high ground, and perceives a strategic advantage to dominating certain key regions of space, either for military or economic advantage. Such an actor would also seek to deny any competitor access to these areas or other areas that would diminish the dominator's relative advantage. The risks associated with such a strategy include high cost of pursuing technologies, miscalculation, potential for arms race, and asymmetric responses by other actors. Space dominators would feel challenged by another space dominator, constrainers, or spoilers.

- **Space protector.** Space protection is an alternate strategy that might be employed by a highly reliant, highly vulnerable space power. The aim of the protector differs in that it seeks only to protect its ability to benefit from space without regard to other actors. In other words, the protector seeks to maximize the absolute benefit it derives from space without concern of relative gain over others. A protection strategy would maximize capabilities such as: SSA; passive or active satellite protection; and operationally responsive space. At the same time, this strategy risks providing a window of opportunity to a competitor to advance its position relative to the protector. A protector would feel threatened by a space dominator or a spoiler, or an actor moving to one of those strategies.
- **Constrainer.** An actor with more limited space capabilities might adopt a constraining strategy to limit relative gains by other actors. A constrainer would likely be less reliant on space than a more comprehensive space power, but may feel threatened by increasing gains by others. Arms control and legal restrictions are favored in this type of strategy as they are used to constrain the power of other actors. The object of this constraining behavior is likely to be a perceived space dominator or a possible spoiler that develops asymmetric capabilities. While attempting to constrain certain actors, this strategy might inadvertently allow other actors to gain primacy.
- **Spoiler.** Like a constrainer, a spoiler may be at a relative disadvantage with regard to other space actors, but this disadvantage is likely to be more strategically significant, particularly in times of crisis or war against a comprehensive space power. A spoiler would seek to employ asymmetric power, such as an ASAT capability to mitigate this vulnerability. Spoilers are most likely to arise in reaction to a space dominator or protector. The spoiler risks miscalculating the response of its object and may find itself as the target of retaliation.
- **Collaborator.** A collaborative strategy may be employed by an actor who does not feel a direct threat from the space capabilities of other actors, and wants to avoid direct security competition in the future. It will seek to protect its absolute gains in space through collective security arrangements and collaboration in other areas. The collaborator seeks interdependence with other space actors to avoid conflict. It may align with a dominator, protector, or constrainer and may feel threatened by a different dominator or spoiler.
- **Free rider.** Free riders seek to minimize their security profile and depend on the protection of the system or of others. They tend not to be in direct competition with other security actors and seek to maximize the absolute benefits they derive from their space activities.

Ideally, stability is best achieved when all actors pursue strategies that seek only absolute gains from their space activity, rather than relative gains in power vis-à-vis other space actors. Protectors, collaborators, and free riders are compatible with mutual gains by other actors. Dominators, constrainers, and spoilers look to enhance their own spacepower or constrain or deny the power of others and therefore, cause more perturbations in the system. The more asymmetry that is introduced among actors, the more unstable the situation. For instance, two dominators in the system may create security problems for each other, but may create a stable system as each one checks the other. Nonetheless, a dominator challenged by a spoiler can lead to conflict as a spoiler sees a narrow window of opportunity for courses of action. Moreover, as perceived security needs change, so will the strategies employed. As one actor perceives a change by another actor, it is likely to adapt if that change creates more vulnerability or offers new opportunities to gain relative advantage.

Summary

The development of spacepower theory is an ongoing process. As the world develops new technologies, employs new ways of using space, and develops new frameworks for regulating it, the impact of space will continue to evolve. Spacepower theory provides the opportunity to

influence this process in a way that maximizes the benefits of space for the global society. The future of humankind will be written by the thought and action of society as it ventures into the universe.