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Integrating National Interests in Space

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In seeking to advance international security interests in space, the context for civil and commercial space activities must be considered along with the context for military and intelligence ones. The international political environment and rationales for space activities are shaped both "hard" and "soft" power realities. A broad international approach to space exploration can play an important strategic role in securing a more stable, peaceful environment for all space activities. Organizing such an approach will not be easy – not the least because of recent US space policy statements and programmatic decisions affecting lunar and Mars exploration efforts. US national interests and those of its friends and allies would benefit from a more effective integration of national security and civil space interests. In particular, this will require amending recent US policy mistakes and addressing shortfalls in important national space capabilities. Looking forward, a program of peaceful, multilateral exploration of the Moon would be a symbolic and practical means of creating a framework for peaceful space cooperation in concert with dual-use discussions of an international space code of conduct and other transparency and confidence building measures.

1.0 NATIONAL INTERESTS IN SPACE

The United States is facing new challenges and new opportunities in integrating its civil, commercial, and national security space interests in the context of a dynamic global environment. Space activities today play critical roles in US national security, economic growth, and scientific achievements. The Global Positioning System (GPS) is an integral part of several critical infrastructures and enables functions ranging from survey and construction, to farming, finance, and air traffic management – not to mention supporting US military forces worldwide. The International Space Station represents a unique collaborative partnership between the United States, Europe, Canada, Japan, and Russia. There is increasing concern in the United States and among other spacefaring nations with the long-term sustainability of the space environment in the face of increasing amounts of orbital debris. International space cooperation, space commerce, and international space security discussions could be used to reinforce each other in ways that would advance US interests in the sustainability and security of all space activities. At present, however, these activities are largely conducted on their individual merits and not as part of integrated national strategy.

Recent years have seen the emergence of new threats to US space activities, threats that are different from those of the Cold War and which have their own distinct dynamics. Threats to the sustainability of space activities today come not from a single superpower but from a much more diverse group of actors whose motivations can range from deliberate to ambiguous and even accidental. In some cases, threats arise from a known nation state while in others, it is impossible to attribute responsibility due to a lack of sufficient "space situational awareness" to support national intelligence needs.

In 2007, without prior notification, China tested a high altitude anti-satellite weapon (ASAT) against one of its old weather satellites. This test created tens of thousands of pieces of orbital debris and increased the risk of collision and damage to many satellites operating in low Earth orbit (LEO), including the International Space Station, for many years. In 2009, there was an accidental collision over the Arctic between a defunct Russian Kosmos communications satellite and an active Iridium communications satellite that added even more orbital debris to low Earth orbit. North Korea, faced with multiple UN sanctions, has continued developing ballistic missile capabilities under the guise of peaceful space launches. Iran continues to jam

commercial satellite broadcasts in order to prevent foreign reports of domestic unrest from reaching its population. There have been reports of attempts at unauthorized access to US civil scientific satellites, e.g., Terra and Landsat in 2007 and 2008, but the source of these attempts has not been confirmed.

The global space community is a growing one with new capabilities and new entrants each year. Europe is building its own version of GPS, titled "Galileo," and has long been a leading supplier of international commercial launch services with its Ariane family of launch vehicles. China has flown several astronauts, becoming only the third country to demonstrate independent human access to space. China is also constructing a space laboratory and has demonstrated complex rendezvous and docking operations in preparation for a fully manned space station in 2020 – about the time the International Space Station may be ending its operations. Japan has updated its domestic space legislation to enable pursuit of national security and dual-use space projects in addition to traditional civil scientific efforts. India has aspirations for its own human spaceflight missions and future lunar landings.

Space commerce is growing at many levels outside of North America, Europe and Russia. Japan has announced plans to sell radar satellites to Vietnam, while South Korea is seeking to sell an optical imaging satellite to the United Arab Emirates. Brazil and China are continuing many years of space cooperation in remote sensing while India and South Africa are close to concluding their own space cooperation agreement. All of these countries recognize that space capabilities are important for both practical and symbolic reasons and that these capabilities are intrinsically "dual-use" in that civil, security, and commercial applications are based on similar skills and technologies.

1.1 US National Space Policy and the National Security Space Strategy

The current US National Space Policy, a comprehensive document that addresses the full range of US interests in space, was released in June 2010.[i] The policy continues many long-standing principles, such as the right of all nations to engage in the peaceful uses of outer space, recognition of the inherent right of self-defense, and that purposeful interference with space systems is an infringement of a nation's rights. The policy states that the United States "recognizes the need for stability in the space environment" and that it will pursue "bilateral and multilateral transparency and confidence building measures to encourage responsible actions in space."

The policy also made some important changes compared to the 2006 National Space Policy of the previous Bush Administration, notably with respect to arms control. Unlike the 2006 policy, the 2010 policy does not categorically reject space-related arms control that would constrain US space activities but states that any such agreements would have to be "equitable, effectively verifiable, and enhance the national security of the United States and its allies." This is a traditional US policy formulation that was also used during the Reagan Administration. There is nothing in the policy, however, about actively pursuing new international treaties, creating legal norms, or characterizing space as a "global commons" or being part of the "common heritage of all mankind" – ambiguous terms that are advocated in some segments of the international space law and policy communities.[ii]

The general coherence on the national security and foreign policy side of the 2010 National Space Policy is not matched in the section of the policy dealing with civil space exploration. The policy says that the NASA Administrator shall "set far-reaching exploration milestones. By 2025, begin crewed missions beyond the moon, including sending humans to an asteroid." Unlike the carefully crafted text elsewhere in the policy, this section appears to have been taken directly from an April 15, 2010, speech by President Obama at the Kennedy Space Center in Florida.[iii] Subsequent technical work has shown that there are few scientifically attractive, technically feasible asteroids that can be reached on this schedule.[iv]

Even worse, the international space community, which had been shifting attention to the Moon in anticipation of that being the next US focus of exploration beyond low Earth orbit, felt blindsided by President Obama's speech and the new US emphasis on a human mission to an asteroid. Countries in Asia, such as Japan, India, China and South Korea, saw the Moon as a challenging but feasible destination for robotic exploration and a practical focus for human space exploration. The asteroid mission was,

perhaps unintentionally on the part of the United States, taken as a sign that the United States would focus on partnerships with the most capable countries, such as Russia, for human space exploration and not engage in broad international cooperation.

The perception that the next steps in human space exploration would be too difficult to allow meaningful participation by most spacefaring countries undercut international support for human space exploration more generally. The lack of US support for a program to return to the Moon made it difficult for advocates of human space exploration in Europe, Japan, India, and elsewhere to gain funding for any efforts beyond the International Space Station (ISS). The ISS is itself under budget pressure to justify its construction and on-going operations costs, a task that has been more difficult by the lack of a clear direction for human space exploration beyond low Earth orbit. The lack of international leadership by the United States may, however, provide an opportunity for rising spacefaring countries such as China to play a greater role in the future. If China is able to offer pragmatic opportunities for space cooperation on its own space station or as part of efforts to send humans to the Moon, other countries will likely it attractive to forge closer relationships with China. A shift in international space influence away from the United States and toward China would have the potential to impact a wide range of US national security and foreign policy interests in space.

The National Security Space Strategy was released in January 2011 as a report to Congress and is intended to provide direction to the US national security space community in planning, programming, acquisition, operations, and analyses.[v] While signed by the Secretary of Defense and the Director of National Intelligence the strategy places a major emphasis on diplomatic activities – a responsibility of the Department of State – as well as dual-use capabilities that are promoted and regulated by the Departments of Commerce, Transportation, and State. The implementation of the strategy says, in part, that (emphasis added):

- "We seek to address congestion by *establishing norms*, enhancing space situational awareness, and fostering greater transparency and information sharing."
- "We seek to address the contested environment with a *multilayered deterrence* approach. We will support establishing international norms and transparency and confidence-building measures in space, primarily to promote spaceflight safety but also to dissuade and impose international costs on aggressive behavior."

A problem with the phrase about establishing norms is that it goes beyond the terms of the National Space Policy. Furthermore, it presupposes there will be some authority by which the norms are established and that the United States will be bound along with other nations.[vi] Many harmful activities such as the intentional creation of long-lived orbital debris and intentional satellite jamming are already contrary to international law, notably the Outer Space Treaty and the Constitution of the International Telecommunication Union. Yet there has been little in the way of sanctions save for international complaints. A more useful statement might have been one about promoting compliance with existing international laws and agreements.

Unfortunately, the US Defense Department uses the legally problematic term "global commons" with respect to space in its most recent Quadrennial Defense Review, dated February 2010.[vii] This term applies to the high seas and the air above them, but is not yet accepted internationally or even officially by the United States. Whether intentional or not, use of the terms "norms" and "global commons" sends mixed messages to international audiences about the US view of space, despite stated desires to reduce miscommunication. Norms of responsible behavior are unlikely to be a serious deterrent to an adversary contemplating an attack on US space systems. Under threat of attack or denial of crucial space systems, other countries may move toward neutrality in a crisis and thus weaken US alliances. In the longer term, they may accelerate the acquisition of independent capabilities rather than be unwillingly "entangled" with the United States.

1.2 An International Space Code of Conduct?

China and Russia have for many years advocated an international treaty barring space weapons as well as the use or the threat of the use of force against space objects. They have introduced a

draft treaty at the UN Conference on Disarmament as part of deliberations on the "prevention of an arms race in outer space" (known as PAROS). The United States has consistently opposed such a treaty as unnecessary, unverifiable, and not in the interests of the United States and its allies. A major flaw in the draft treaty continues to be the difficulty in defining just what a space weapon is; even if defined, the Chinese-Russian text leaves out ground-based systems such as interceptors and lasers. Consideration of a verifiable agreement, based on behavior, to ban the intentional creation of long-lived orbital debris has not gained much traction due to the impasse over the Chinese-Russian proposal.

Regardless of differing viewpoints on weapons in space, there is wide international concern with the "sustainability" of space activities among both developing and developed spacefaring states. Orbital debris, regardless of origin, and radiofrequency interference are hazards to all space operations. Rather than a "top down" negotiation of a treaty among major space powers, the development "bottom up" of technical best practices to mitigate hazards can be a more effective means of engaging a wider range of space actors. This is the approach taken in the development of orbital debris mitigation guidelines over several years in the Scientific and Technical Committee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). The guidelines have helped mitigate the creation of new debris but more needs to be done as the growth of debris has only slowed, not reversed. Actual reversal in the numbers and mass debris will likely require "active debris removal" – a topic fraught with a technical, economic, and political challenges.[viii]

The European Union has proposed a draft "Code of Conduct for Outer Space Activities" that would be a collection of non-legally binding transparency and confidence building measures (TCBMs) and norms for space. Such measures would be purely voluntary by subscribing states, with no international enforcement mechanism, except the political stigma associated with their intentional violation. Verification of adherence to particular TCBMs would be left to the capabilities of each member. A draft code released by the European Union in October 2010 calls for states to "refrain from the intentional destruction of any on-orbit space object or other activities which may generate long-lived orbital debris" and for signatories to share information on their space policies and practices.[ix] Procedurally, the code is being discussed outside of both COPUOS and the Conference on Disarmament as the former does not deal with security issues and that latter is deadlocked on other, non-space security issues. This is an approach that avoids being constrained by the existing structures of UN organizations while being open to all interested parties.

Considerable expert-level consultation will be needed before consideration could be given to calling a diplomatic conference for a code of conduct. While the United States and its traditional allies could likely come to an agreement, it is also important to draw in other spacefaring nations outside Europe, Canada, Japan and the United States. The United States and its allies do not have space security concerns with each other as much as they do with the BRICS (Brazil, Russia, India, China and South Africa) - not to mention North Korea and Iran. An international space code of conduct will be valuable to the extent it can create a consensus with other spacefaring states around the world. Establishing such a consensus, however, is likely to take longer with countries that do not have a history of close civil space cooperation with the United States. European efforts to explain their draft proposal immediately prior to the June 2012 plenary meeting of COPUOS met with skepticism from many developing countries. These countries were surprised by the proposal and questioned why it was being pursued outside of traditional UN forums.

There will also be skepticism from some in the US Congress toward a code of conduct. In February 2011, a group of 37 Republican Senators sent a letter to Secretary of State Hillary Clinton expressing concerns that US acceptance of a space code of conduct would constrain US space capabilities.[x] They wrote, "We are deeply concerned that the Administration may sign the United States on to a multilateral commitment with a multitude of potential highly damaging implications for sensitive military and intelligence programs (current, planned or otherwise), as well as a tremendous amount of commercial activity." In particular, the Senators were concerned with possible constraints on space basing of missile defense interceptors and anti-satellite weapons as well as the costs of compliance. A code that helps to single out rogue actors and reduces the risk of orbital debris

to US space operations might be accepted. The Senate will likely reject a code that tries to go further and limit ballistic missile defenses or which seems to discriminate against the United States.

A more subtle US domestic concern with a space code of conduct is whether it becomes a pretext for avoiding costly improvements in space mission assurance and resilience of critical military functions during conflict. International political agreements are a poor substitute for having actual capabilities to, as the National Space Policy requires, "deter, defend against, and, if necessary, defeat efforts to interfere with or attack US or allied space systems." Deterrence in space is no different from deterrence on the land, seas or in the air: the focus is on understanding the thinking of an opponent. Ensuring adequate military capabilities requires understanding how space systems fit into joint and combined arms campaigns, as well as understanding the views and values of potential adversaries. This in turn may well suggest steps toward greater international cooperation with friends and allies. Codes of conduct and other "transparency and confidence building measures" can be helpful in reducing the chances of accidental conflict and in providing cues to unusual activities. Codes and TCBMs should not, however, be seen as a substitute for the military capabilities necessary to deter potential adversaries and meet US alliance commitments.

2.0 DOMESTIC CHALLENGES FOR US SPACE ACTIVITIES

The next US Administration – whoever the president may be – will face major policy and programmatic challenges in every space sector – civil, military, intelligence, and commercial. US technical capabilities today are dramatically superior to what they were at the opening of the Space Age or even during the Cold War. However, in relative terms and compared to the importance of space to US national interests, the trends are worrisome as they represent shortfalls in US space capabilities and disconnects between US policy statements and actions. The United States does not currently have human access to space and its space situational awareness capabilities lag in comparison to the needs created by a more complex and congested space environment. It is difficult to discuss national security space activities due to a lack of publicly available information. The domestic challenges for US space activities can be illustrated however by the experiences of NASA in recent years.

The loss of a second Space Shuttle, the *Columbia*, in 2003 resulted in the decision to retire the fleet after completion of the International Space Station. The *Columbia* Accident Investigation Board recommended that "because the Shuttle is now an aging system but still developmental in character, it is in the nation's interest to replace the Shuttle as soon as possible as the primary means for transporting humans to and from Earth orbit." The Board noted the failures in developing the National Aerospace Plane, the X-33, X-38, or any replacement for the aging Space Shuttle with the observation, "previous attempts to develop a replacement vehicle for the aging Shuttle represent a failure of national leadership."[xi]

Plans to replace the Shuttle with a government-led system were disrupted by the 2010 decision to cancel NASA's Constellation program and shift to reliance on new private providers of crew launch services. The last Shuttle flight occurred in 2011 and the United States is now reliant on Russia for human access to space. While the Bush Administration contemplated a four-to five-year gap in US human access to space, strictly because of budget considerations, the current gap may now be more than six years. This is due to a change in strategic direction, i.e., NASA is no longer managing the development of human space transportation systems for access to low orbit. In August 2012, NASA announced the selection of three companies, SpaceX, Boeing, and Sierra Nevada as part of its Commercial Crew Integrated Capability Initiative (CCiCap). The firms are being funded to develop a privately owned and operated means of carrying crew to and from the International Space Station. NASA plans to fund only one company through to its "critical design review" before the construction of operational vehicles. If successful, the first flights could occur by 2017.[xii]

In addition to the cost of paying Russia for crew transportation, US partners are concerned with relying on a single country for access to the International Space Station. Multiple Russian launch failures - Proton upper stage losses in August 2012 and December 2010, a Rockot loss in February 2011, Soyuz and Proton-M failures in August 2011, the Phobos-Grunt Mars mission

loss on a Zenit in November 2011, and another Soyuz failure in December 2011 - have raised concerns that Russia's traditional strength in reliable launch vehicles may be fading. The successful berthing of the unmanned SpaceX Dragon cargo vehicle on the International Space Station in May 2012 was a welcome step forward in restoring a limited US capability to send supplies to and bring back materials from the Station. It was only an early step, however, toward restoring a US human spaceflight capability.

In addition to disruptions in US human space flight, the United States was unable to make a long-term financial commitment to Europe for a program of robotic exploration of Mars, despite years of involvement in the planning process. This prompted the European Space Agency to invite Russia to be a full partner in the ExoMars program in October 2011 after discussions with the United States reached an impasse. Budget constraints have similarly prevented domestic production of Plutonium-238 after Russian supplies ran out. This nuclear fuel is critical to providing electrical power to missions traveling beyond Mars and long-term exploration of the planets. There is enough fuel for one more "flagship" mission but that will be the end of such missions without new supplies. Finally, budget uncertainty has caused delays in the construction of the next series of weather satellites and the United States may be facing a multiyear gap in meteorological data that will result in less accurate near-term weather predictions. All of these incidents create credibility issues and complications for US efforts to expand international cooperation in space.

Financial turmoil is not the only source of difficulty for US space operations. For more than a year, the Federal Communications Commission (FCC) has been considering allowing a terrestrial broadband company to operate in the spectrum adjacent to GPS. This spectrum has been previously allocated to satellite services that were compatible with GPS. Unfortunately, testing has shown that the proposed terrestrial broadband service would create unacceptable interference to many, if not all, GPS-enabled services. The regulatory uncertainty at the FCC prompted formal expressions of international concern from the European Commission, the Japanese Government, and the International Civil Aeronautics Organization (ICAO) over possible interference to satellite-based positioning and navigation. The international community has been puzzled by the US debate over possible interference to GPS, as the National Space Policy clearly requires the "protection of radionavigation spectrum from disruption and interference."

2.1 NASA Budget Instability

Government budgets for space activity are of obvious interest to the Department of Defense, NASA, and NOAA, as well as their contractors. Large capital investments, large fixed costs, and highly specialized technical talent characterize major sectors of the space business, like space launch. This means that timing, phasing and stability of funding is often just as important as the total level of funding. Unfortunately, recent years have been characterized by both lower funding AND greater volatility. Figure 1 shows NASA budget requests since the beginning of the current Administration. The FY 2010 budget was flat and characterized as a "placeholder" pending the Augustine Committee's review of plans for human space flight in 2009.[xiii]

The FY 2011 request released in February 2010 restored the NASA top-line to the level it had been during the previous Bush Administration – but with a significantly different portfolio, i.e., with more funds for commercial crew development, technology and Earth science missions. The Obama Administration's budget proposal also cancelled the Constellation program to develop the Orion capsule, the Ares I launch vehicle, and the subsequent Ares V heavy lift vehicle. These capabilities were intended to support a human return to the Moon in the early 2020s and create the foundations for eventual human missions to Mars. The US Congress opposed the cancellations and protracted political struggle ensued, which eventually resulted in the NASA Authorization Act of 2010. This Act did not provide significantly different total funding for NASA, but it did restore funds to develop the Orion and a shuttle-derived heavy lift vehicle called the Space Launch System. The lunar focus was replaced by what NASA termed a "capabilities-driven" evolution in which various missions would be defined as new capabilities were demonstrated.

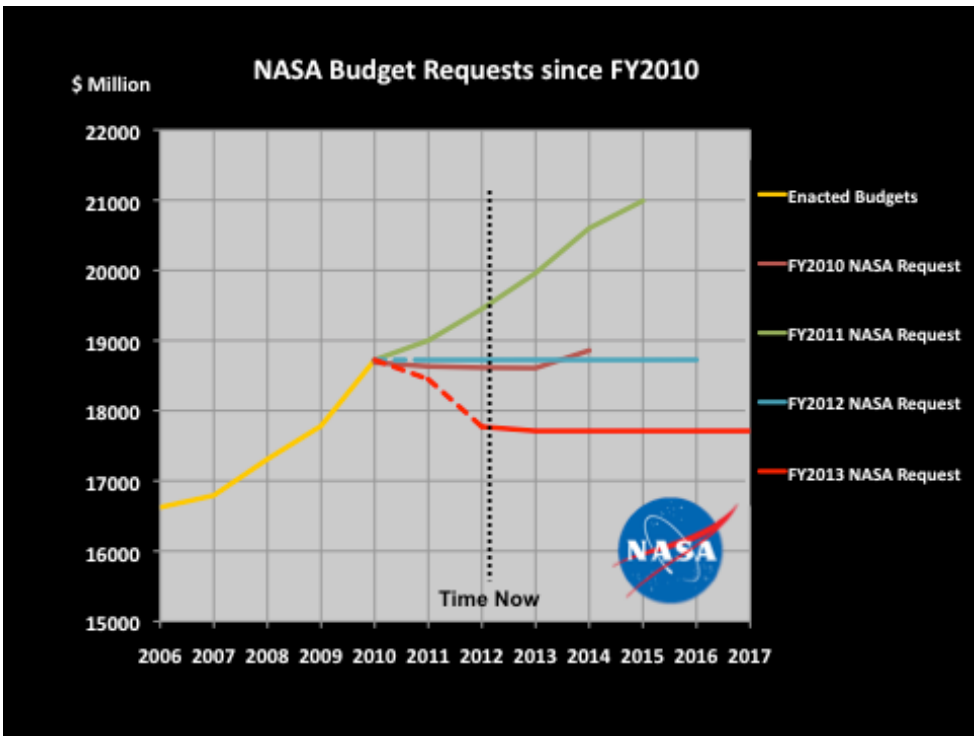

Figure 1 – NASA Budget Requests since FY 2010

The NASA budget profile again declined in the FY 2012 request. The budget was flat and at the level of the earlier FY 2010 "placeholder" proposal. The FY 2013 request declined again, with NASA now projected to be flat at even lower levels. Adding to the uncertainty, NASA and OMB did not even share the same projected spending levels in future years. In both the FY 2012 and FY 2013 budget requests, the phasing of reductions was different with near term declines and farther term increases contrasted with flat projections. Notwithstanding wry comments about "flat being the new up" such uncertainty and reductions in real purchasing power is more accurately described as "less is less." The phasing of reductions and differences over them makes it more difficult for NASA and industry managers to plan work efficiently.

The impact of budget volatility has been especially severe in the case of human space exploration. Figure 2 shows reductions in NASA's exploration budget since FY 2009, the last budget of the previous Administration. Notwithstanding the volatility of the NASA top line, the steady trend in exploration has been down. For FY 2011, 2012, and 2013, the lines in Figure 2 assume that 100% of the space technology budget line contributes to exploration. If the actual percentage is less, say 50%, then the decline is even more dramatic. NASA is still a large and capable agency, but an increasing proportion of its resources are not going to human space exploration.

NASA's budget request for 2013, $17.7 billion, is virtually the same as it was for 2009. The Augustine Committee's recommendation to increased NASA's total budget by $3 billion per year was clearly not heeded. An obvious question to ask is whether any other budgetary outcome would be affordable. NASA's budget is less than 0.5 percent of the entire Federal budget. From that perspective, the NASA budget is not a question of affordability but of priorities. In today's environment with massive debt and an anemic economic recovery, sustaining discretionary expenditure for civil space exploration will be especially challenging unless there is a clearer rationale linking such efforts to broader national interests that can be supported in a bipartisan manner over many years.

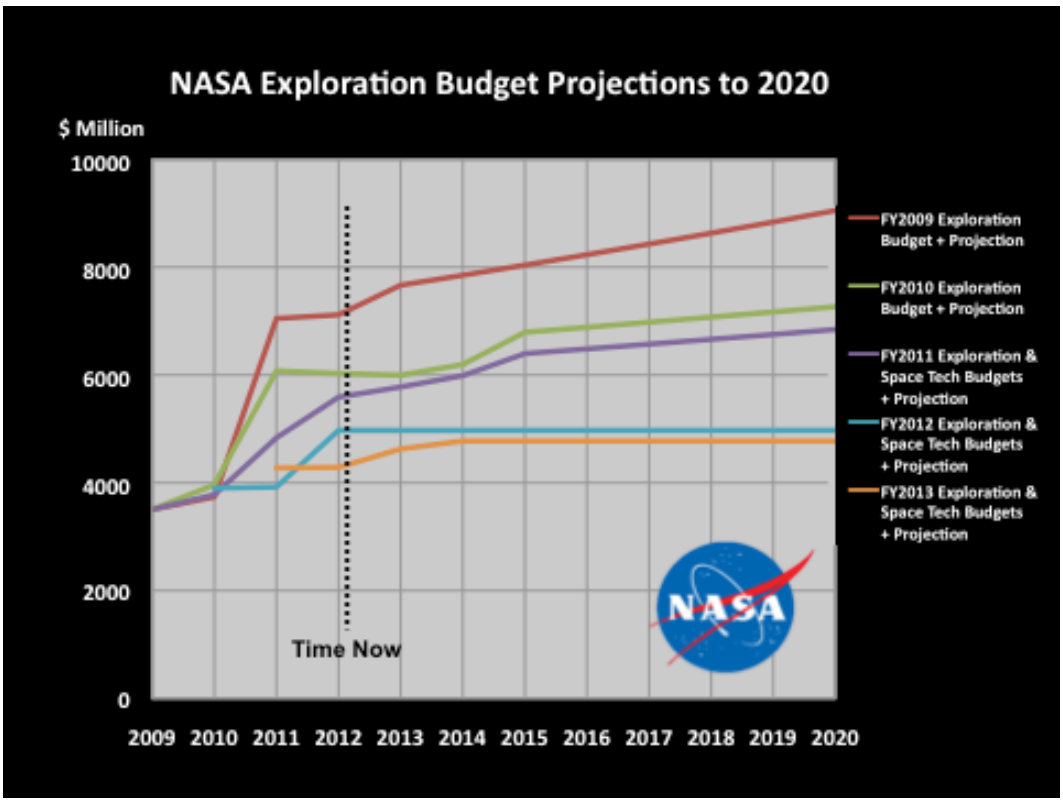

Figure 2 – NASA Exploration Budget Projections

3.0 STRATEGIC APPROACHES TO HUMAN SPACE EXPLORATION

Unmanned space exploration efforts in planetary science, astrophysics, and heliophysics are under great stress due to budget overruns and schedule delays from large "flagship-class" efforts (e.g., Curiosity Mars Science Laboratory and James Webb Space Telescope). This has resulted in cancellation of smaller, lower priority missions and a reduction in flight opportunities for researchers not already on the largest programs. The problems faced by these science programs are programmatic, not existential, questions. There is no debate in the United States about whether to have a space science program, but rather what level of effort is affordable and executable.

In contrast, there is an on-going debate over whether and what kind of human space exploration effort the United States should have. While many supporters of human space flight see such efforts as "inevitable" or "part of our destiny," those views are not widely enough held to ensure stable political support. At the same time, there is a level of support for the political symbolism of human space flight and a sense that it may have longer-term practical value that make US political leaders reluctant to cancel such efforts or to be seen as supporting such an action. Human spaceflight (if not pure exploration) may one day become a self-sustaining commercial activity but that day has not yet come.

There are many diverse reasons individuals may have for supporting human space flight along with many different activities that could constitute an on-going human space flight effort, e.g., space tourism, landing on Mars, exploiting space resources, etc. Aside from an Apollo-like crisis, which seems unlikely to reoccur, there seems to be three major alternative strategic approaches the United States might take toward human space exploration: 1) Capability-driven, 2) Question-driven, and 3) Geopolitically-driven.

3.1 Capability-driven

The current US approach to human space exploration is officially described as "capability driven":

"NASA's human space exploration strategy focuses on capabilities that enable exploration of multiple destinations This capability-driven approach is based on a set of core evolving capabilities that can be leveraged or reused, instead of specialized, destination-specific hardware This approach is designed to be robust, affordable, sustainable, and flexible, preparing NASA to explore a range of destinations and enabling increasingly complex missions."[xiv]

This approach does not focus on a specific destination, question, or purpose for human space flight, but rather seeks to keep a range of options open while deferring decisions on specific architectures and rationales. In a budget constrained environment without any specific political or economic rationale, such an approach avoids taking a decision to cancel human space flight and the need to specify what human space flight should accomplish.

This is not the first time the United States has taken this approach. In the aftermath of the Apollo program, the Nixon Administration did not want to cancel human space flight but neither did it want to continue the costs and risk of human missions to the Moon and eventually Mars. In 1970, while the lunar landings were still underway, President Nixon said:

"We must realize that space activities will be a part of our lives for the rest of time. We must think of them as part of a continuing process-one which will go on day in and day out, year in and year out -- and not as a series of separate leaps, each requiring a massive concentration of energy and will and accomplished on a crash timetable.... We must also realize that space expenditures must take their proper place within a rigorous system of national priorities."[xv]

The 1972 decision to build the Space Shuttle was explained by NASA Administrator James Fletcher in a similar, low-key fashion:

"There are four main reasons why the Space Shuttle is important and is the right step in manned space flight and the US space program.
1. The Shuttle is the only meaningful new manned space program which can be accomplished on a modest budget;
2. It is needed to make space operations less complex and less costly;
3. It is needed to do useful things, and
4. It will encourage greater international participation in space flight."[xvi]

In essence, NASA would develop a human space flight capability that would continue to enable the United States to send humans into space, be more affordable, and hopefully accomplish useful tasks still to be determined. The Obama Administration's approach is arguably similar to that taken by the Nixon Administration in the early 1970s.

3.2 Question-driven

An alternative strategic approach is to take an intentionally question-driven approach and pose questions or grand challenges to be addressed by human space exploration efforts – or at least those efforts that rely on public resources. In this approach, a program of human space exploration is more than a series of spectacular engineering demonstrations – as in the case of Apollo – but a means of answering questions important to society. After gaining foundational capabilities like space transportation, communications, navigation, and power, an exploration program could look to use in-situ resources, create new resupply methods (e.g., in-space propellant depots), and commercial partnerships. This could help move debates beyond "robots versus humans" or "Moon versus Mars" or "Science versus Exploration" to a more question-driven, mission-focused series of decisions.

Just as the *Challenger* accident led to questioning whether human life should be placed at risk in launching satellites that could be carried by an unmanned rocket, so the *Columbia* accident led to asking for what purposes, if any, was risking human life worthwhile. The Columbia Accident Investigation Board concluded that the nation should continue a program of human space flight, eventually moving beyond Earth orbit. Although not stated explicitly, the implication was that if the nation were to continue to place human life at risk, staying in low Earth orbit was an insufficient goal to justify such risks.

For those who believe that human expansion into the solar system should be an important part of what the United States does as a nation, abandoning human space flight completely or even staying in low Earth orbit would be politically unacceptable. However, there are

many who do not share the same feeling about the priority of human space flight to the nation and it would be helpful to squarely acknowledge that uncertainty. The original decision to go to the Moon was an answer to President Kennedy's question on whether there was any area in which the United States had a chance of surpassing the Soviet Union. The change in payload policy after *Challenger* was an answer to question about relative risk and reward of using humans for satellite deployments. The recommendation of the CAIB to eventually go beyond LEO was in response to the question of using humans in space at all, posed by the loss of *Columbia*.

Today, what is the question for which the human exploration of space is the answer? A useful high-level question for human space exploration could ask, "Does humanity have a future beyond the Earth?" Either a yes or a no answer would have profound implications. Addressing this question quickly leads to two sub-questions: can humans "live off the land" away from Earth, and is there any economic justification for human activities off the Earth?[xvii] If the answer to both questions is yes, then there will be space settlements. If the answer to both questions is no, then space is akin to Mount Everest – a place where explorers and tourists might visit but of no greater significance. If humans can live off-planet, but there is nothing economically useful to do, then lunar and Martian outposts will, at best, be similar to those found in Antarctica. If humans cannot live off-planet, but there is some useful economic activity to perform, then those outposts become like remote oil platforms. Each of these scenarios represents a radically different human future in space and while individuals might have beliefs or hopes for one of them, it is unknown which answer will turn out to be true. That is, the answer can only be found by actual experience.

The science community has used the productive practice of posing simple but profound questions to shape and guide the implementation of research strategies. Asking, "is there life elsewhere in the universe?" leads to questions of whether there is life elsewhere in the solar system, the search for water on Mars, and missions exploring for water and signs of life in particular locations. These questions shape the design and execution of space missions. The human space flight community could benefit from adopting similar practices to design and prioritize its missions. In this vein, consideration should be given to a routine survey that assesses progress in (or lack of) human spaceflight and reviews priorities on a ten year time scale as done for scientific fields. Such routine reviews could also improve the stability of human spaceflight efforts across Administration transitions. If the United States could shift away from existential debates on whether or not to have a human space exploration effort, it could use open, enduring questions to guide programmatic decisions for an affordable and effective human spaceflight effort. For example, priority could be given to answering such questions as: whether humans can operate effectively away from Earth for long periods of time, can they utilize local resources to lower reliance on materials from Earth, and whether self-sustaining commercial activities (requiring direct or close human involvement) are viable.

3.3 Geopolitically-driven

The third strategic approach is the most historically common for the United States, a human space exploration effort driven by geopolitical interests and objectives. The United States undertook the Apollo program in the 1960s to beat the Soviet Union to the Moon as part of a global competition for Cold War prestige. The Apollo- Soyuz program symbolized a brief period of détente in the 1970s. The Space Station program was established in the 1980s, in part, to bring the developing space capabilities of Europe and Japan closer to the United States and to strengthen anti-Soviet alliances. Russia was invited to join a restructured International Space Station in the 1990s to symbolize a new post-Cold War, post-Soviet relationship with Russia. What might be the geopolitical rationale for the next steps in human space exploration?

It is well recognized that many of today's most important geopolitical challenges and opportunities lie in Asia. States under UN sanction, for example, Iran and North Korea, are seeking to develop ICBM capabilities under the guise of space launch programs. China, India, and South Korea are demonstrating increasingly sophisticated space capabilities that serve both civil and military needs. Examples of these capabilities include satellite communications, environmental monitoring, space-based navigation, and scientific research. Unlike Europe, there are no established frameworks for peaceful space cooperation across Asia. In fact,

the region can be characterized as containing several "hostile dyads" such as India-China, North Korea-South Korea, and China and its neighbors around the South China Sea.[xviii] The United States has better relations with almost all of these countries than many of them have with each other.

Asian space agencies have shown a common interest in lunar missions as the logical next step beyond low Earth orbit. Such missions are seen as ambitious but achievable and thus more practical than missions to Mars and more distant locations. They offer an opportunity for emerging and established spacefaring countries to advance their capabilities without taking on the political risks of a competitive race with each other. A multilateral program to explore the Moon, as a first step, would be a symbolic and practical means of creating a broader international framework for space cooperation. At the same time, the geopolitical benefits of improving intra-Asian relations and US engagement could support more ambitious space exploration efforts than science alone might justify. In concert with discussions of an international space code of conduct, a broad program of human space exploration would help garner support for other international objectives in support of US interests, both on Earth and in space.

4.0 INTEGRATING NATIONAL INTERESTS IN SPACE

Negotiations over possible "rules of the road" in space will not occur in isolation from other aspects of the international environment. From the beginning of the Space Age, space activities have been "tools" of both hard and soft power for participating nations. Hard power is represented by alliances, military capabilities, and economic strength that can compel and pay others to do what we desire. Cultural, diplomatic, and institutional forces are aspects of soft power by which we are able to persuade others to do what we desire. In seeking to advance international space security interests, the soft-power influence brought about by leadership in civil and commercial space activities must be considered. Countries lacking a stake in stable, peaceful space environment are unlikely to be supportive of US and allied space security concerns. It is not that those counties will be opposed to security concerns, but that they will not see the relevance to their own needs and interests. As an example, international interest in mitigating orbital debris has grown as more countries have realized the threat such debris can pose to space systems they rely on and their citizens who may be working in space.

Organizing a broad international approach to space exploration and space security will not be easy – not the least because of errors and confusion in recent US space policy statements, strategies, and programs. US global influence has been diminished by removal of the Moon as a focus for near-term human space exploration efforts, a failure to cooperate with Europe on the next stage of robotic missions to Mars, and limitations in space object tracking and notification capabilities that would reduce the risk from orbital debris for all space users. Potential international partners have been confused by a lack of clear US space goals and priorities and looking beyond the International Space Station, they have not seen opportunities for engagement other than in individual scientific collaborators. As one European space agency head put it, "there is lots of cooperation with Europeans, just not with Europe."[xix]

A more effective integration of national security and civil space interests in support of US national security and foreign policy objectives would benefit from amending recent mistakes, providing clearer priorities and leadership, and creating broader bipartisan support for both civil and national security space efforts. Doing so would in turn enable opportunities for creating a more stable strategic environment that would benefit all countries as well as the United States. International space cooperation, space commerce, and international space security discussions could be used to reinforce each other in ways that would advance US interests in the sustainability and security of all space activities.

4.1 Recommendations

A fundamental truth for government space programs is that budgets are policy. So the first consideration for any policy choice and implementing architecture is that it be funded – with clear priorities on which schedules and performance goals will be relaxed if resources are not forthcoming. To do otherwise is to imperil mission success and it would be more realistic to do and say nothing. Thus a fundamental recommendation is to ensure that space policies, programs, and budgets are in

alignment, since to do otherwise is to invite failure.

The most immediate human space activity is the on-going International Space Station. Now that construction has been completed, the priority of all the partners is rightly on utilization. Whether the Station is sustained beyond 2020 will likely depend on both the cost of continuing operations and research results. If costs are high compared to demonstrated and likely results, the partners could decide to end the program. If operating costs are affordable and research results sufficiently impressive, then the program may continue for many years. In this way, the Station will be less of a political statement in the future than it will be a major scientific facility to be treated in a similar manner.

Since major space projects take so long to implement, it is appropriate to be working now on what should come after the Station – even if the Station's end date is not certain. It is generally assumed that human space exploration beyond LEO will not be done by individual nations (save perhaps China) so it makes sense to ask potential international partners what they are capable of and interested in doing. In this regard, human missions to asteroids or Mars are beyond the practical capabilities of almost all potential partners (save perhaps Russia). If there is a serious effort to engage international partners, a lunar-based architecture is most likely to emerge as the next focus of human exploration. US national space policy should be updated to recognize and support such an effort. In addition, a lunar focus would provide practical opportunities for using private sector initiative, e.g., cargo delivery to the lunar surface. This could be done in analogy to International Space Station cargo delivery, but it would represent at least an order of magnitude greater addressable market even for an initial lunar base with the same number of crewmen as the Station.[xx]

Despite the spectacular success of the August 2012 landing of Curiosity on Mars, the future of unmanned Mars exploration remains highly volatile. No clear path forward exists for returning samples from Mars or what flagship mission will come next (if any). In the longer term, there is uncertainty that robotic Mars exploration can continue to be productive and sustainable separate from human space exploration efforts. For example, there is little impetus to develop ever more capable entry-descent-landing (EDL) techniques without the goal of eventually being able to land humans on the Martian surface. At the same time, robotic precursors will be needed for any human space explorations beyond Earth orbit. Human and robotic missions should be more closely integrated to benefit both science and exploration. Even if human missions to Mars come decades after a human return to the Moon, it will still be beneficial for robotic precursor missions and human exploration plans to be closely aligned with each other. These efforts draw on similar technical capabilities and, for government-funded missions, similar sources of budgetary and political support.

International discussions of a space code of conduct should continue. This is a means of engaging with emerging spacefaring countries while avoiding the distractions of unverifiable space-based arms control treaties. Such discussions recognize the diversity and scope of space actors, not just among states, but in the private sector as well. Constraints on all government budgets are such that private sector initiative, partnerships, and competition will be of increasing importance to many (but not all) space activities. In recognition of this fact, international discussions should also include measures to create greater regulatory stability and encouragement for private space activities. Legal support for the private utilization and exploitation of non-terrestrial materials and functional property rights should be part of incentives for space commerce and development.

Human space exploration is at a crucial transition point with the end of the Space Shuttle program and the lack of clear objectives beyond the International Space Station. New space actors are present who lack experience in major space projects with the United States. At the same time, these actors have the potential to affect the sustainability of the space environment and thus impact US interests in space. The seemingly separate threads of human, robotic, civil, commercial, and national security space activities are in fact deeply intertwined with each other, both politically and technically. The United States can best advance its national interests through a more integrated strategic approach to its national security and civil space interests. In this way, the United States and its allies can shape an international environment conducive to peaceful space activities of all kinds in the decades ahead.

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