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ABSTRACT: The United States is a space-faring nation and historically a leader in space exploitation and exploration. It has worked for more than 50 years to ensure access to, and unconstrained maneuver through, space for military, civil, and commercial purposes. As a vital element of U.S. national security, space activities provide the nation with unique capabilities for national and military intelligence, precision navigation, global communications and financial transactions, and entertainment. America's unfettered access to space is facing increasing challenges from globalized competition, restrictive international trade policies, an endangered domestic industrial base, and an increasingly crowded operational space environment. In spite of early pessimistic views of the Space Industry by Study Seminar members, the study concludes with an optimistic outlook for this critical, healthy and vibrant industry. U.S. Government action to establish a unifying policy for operations in space, and immediate reforms of international trade regulations will help to ensure the future vitality of the industry.

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INTRODUCTION

"The present extent of U.S. dependence on space, the rapid pace at which this dependence is increasing, and the vulnerabilities it creates, all demand that U.S. national security space interests be recognized as a top national security priority."[1] Air Force Chief of Staff, General Norton Schwartz, succinctly characterized the importance of space as "the ultimate high ground."[2] In defining his vision for the next phase of U.S. space activities, President Barack Obama stated that space "is not a luxury, it's not an afterthought in America's quest for a brighter future. It is an essential part of that quest."[3]

The United States is a space-faring nation and historically a leader in space exploitation and exploration. The nation has worked for more than 50 years to ensure access to, and unconstrained maneuver through, space for military, civil, and commercial purposes. As a vital element of U.S. national security, space activities provide the nation with unique capabilities for national and military intelligence, precision navigation, global communications, financial transactions, and entertainment. The American people, and increasingly citizens of nations around the globe, benefit, perhaps unknowingly, from space activities through better economic, environmental, and physical security and rapid, yet relatively inexpensive, access to global communications, entertainment, and convenience.

The purpose of this study was to enable members of the 2010 Industrial College of the Armed Forces (ICAF) Space Industry Study Seminar to explore the various elements that comprise "space" in order to develop an understanding of the relationships, challenges, and opportunities associated with this critical industry. This report is the culmination of five months of focused study and analysis of the space industry, during which the Study Seminar visited national security, civil, and commercial space agencies, industries, and facilities in the U.S. and Europe. Seminar members gained insight into the complexity and challenges of space operations through invaluable, frank, and informative discussions with military, government, and civilian executives and experts. The fifteen students who conducted this study, under the mentorship of the ICAF faculty, came from diverse U.S. Government and military backgrounds. Some had extensive space operational or acquisition experience. Other students' connection to space was limited to the unconscious reliance of a simple Automated Teller Machine transaction on the precision timing capability provided courtesy of the U.S. Air Force's constellation of Global Positioning System (GPS) satellites, hurling through space at more than 8,600 miles per hour, 12,550 miles above our heads.

The Seminar focused on the U.S. domestic industry and somewhat less so on the European space industry. Seminar members came to realize the importance of the influence of other key space players such as Brazil, Russia, India and China, and of developing players such as Iran, but limited resources, particularly time, did not allow for detailed research on their space programs.

This Space Industry Study Report attempts to capture the complexity of the industry in a simplified definition. It follows with an assessment of the current conditions and challenges within the industry and assesses its outlook for the future. Essays on issues that this year's study participants believe to be most pressing are also included. Study Seminar-derived recommendations to address the challenges identified herein conclude the report.

THE INDUSTRY DEFINED

According to the online reference, Investopedia, an industry is "[a] classification that refers to a group of companies that are related in terms of their primary business activities."[4] Investors and economists study industries to understand the factors that create or limit corporate growth and profit. For this purpose, it is useful to group companies that have the same or similar product or process. One such grouping methodology is the North American Industry Classification System (NAICS), which is widely used by investors to classify companies into industries. For example, under this system, the "space industry" is normally grouped into NAICS code 33641b, Guided Missile & Space Vehicle Manufacturing. In the U.S., space launch vehicles and spacecraft (manned and unmanned) are grouped in this code.

In his widely acclaimed book on competitive strategy in business, noted economist and author, Michael Porter states, "[a]ny definition of an industry is essentially a choice of where to draw the line between established competitors and substitute products, between existing firms and potential entrants, and between existing firms and suppliers and buyers."[5] Porter's broader look at the purpose for defining an industry provided the basis for the Seminar's study of space.

On the consumer demand side of the industry, it is generally easy to draw the line between three customer groups. They are national security (includes military and intelligence), civil (National Aeronautics and Space Administration (NASA) and all non-defense U.S. Government space activities), and commercial. On the supply side of the industry, it is useful to distinguish between space infrastructure, and space products and services. Space infrastructure includes the enabling hardware such as launch vehicles, satellites, spacecraft, and probes, and supporting organizations and processes such as ground-based command and control, space insurance, and venture capital.[6]

The Seminar's definition of the space industry is "one that provides space infrastructure, products and services to national security, civil and commercial customers."

CURRENT CONDITIONS

The use of space has become an irrefutable natural resource and is similar to other resources such as land, water, oil, or iron ore. As a factor market, space has ceased to be a frontier; instead, it has emerged as a resource contended by national security, civil, and commercial entities. Space is also a product market in that many of today's high-technology products and services contain space as an indispensable ingredient. This brief assessment of the current conditions covers some key industry sectors.

National Security Space

The U.S. military continues to enjoy preeminent advantage in the national security space arena; however, budgetary pressures and a lack of balance between the rising costs of maintaining inventory and the growing need for greater capabilities contribute to some difficult choices ahead.

An important development has been some migration of Earth observation capabilities from national security-focused programs to civilian commercial operations. This use of commercial space services by U.S. Government agencies, especially the military and intelligence agencies, provides a combination of added capability and ease of sharing due to the unclassified

nature of the products. It does add some risks because of the potential for the same data being made available for sale to adversaries.

Civil Space

Government space budgets increased considerably from 2008, demonstrating an aggregate growth rate of 16 percent and representing 25 percent of the total market value in 2009. The international governments' 2009 budgets increased by 23 percent from 2008, reaching the highest amount of total funding invested at $21.75 billion.[7] This increase includes the first time data on government space budgets for the European Union, Argentina, Chile, Spain, Nigeria and South Africa, reflecting the continued growth of the space economy outside of the U.S.

In February 2010, President Obama's Fiscal Year (FY) 2011 budget request included a new direction for NASA, revamping the human spaceflight programs onto a new twenty-year course and rededicating the agency to developing advanced technologies. The proposed FY 2011 budget increases funding for NASA by six billion dollars over five years and provides new support for technology development, Earth observation and aeronautics.[8] Rationalizing that the Constellation program was "over budget, behind schedule, and lacking in innovation due to a failure to invest in critical new technologies," the President's budget effectively cancelled the program.[9] In an attempt to free NASA's resources to concentrate on longer term goals of space exploration, the budget seeks increased reliance on private contractors to transport astronauts to and from the International Space Station (ISS).

Commercial Space

The satellite sector, comprising ground equipment, launch, manufacturing and services, is the most commercial segment of the space industry and is in the mature stage of the lifecycle with the emergence of a standard design for the satellite bus. In terms of demand, commercial communications satellite manufacturing outpaces others such as imagery and remote sensing. In response to new market demands, companies have turned to economies of scale, exploration of emerging technologies, more rapidly deployable boosters, standardized "plug-and-play" platforms, and miniaturization.[10] High capitalization, government and international regulations, competition for a highly technical workforce, and entrepreneurial (catastrophic) risk act as high barriers to entry. Typical of oligopolistic competition, fewer than ten companies account for a significant share in any individual market.

Satellite services showed continued strong growth of 16 percent annually during 2003 – 2008 with revenues of $39.8 billion in 2003 climbing to $84 billion in 2008, solidifying its role as the driver of this industry.[11] In 2009, satellite services continued to grow, reflecting an estimated market value of $90.58 billion and representing 35 percent of the space economy.[12] The second largest driver of spaced-based revenue is space infrastructure, which comprises spacecraft manufacturing, launch services, in-space platforms, and ground equipment. Space infrastructure accounted for $83.63 billion or 32 percent of the total market value in 2009.[13]

Global Recession-Proof Growth

Being a lagging economic indicator, and given the multi-year lead times to launch, the commercial satellite sector, and commercial space in general, have been largely immune to the current global recession. Recent increases in space spending by the U.S. Government and its use of more commercial services contributed to the space economy at large. The Space Foundation

reported that the global space business grew to $261.6 billion in 2009, expanding seven percent from 2008 and 40 percent over the past five years at a time when the recession hit other industries.[14] Commercial satellite services, which generate revenue from telecommunications, and Earth observation, remain the largest driver of space-based revenue. There is increasing interest in imagery applications, 3D content for television, internet access via satellite, hybrid satellite-terrestrial communications, and satellite radio.

Emerging Global Competitors

China is becoming an especially formidable space power, possessing considerable launch, communications, satellite, sensing, position, navigation, and timing capabilities. Its counter-space capabilities and intentions are an increasing U.S. national security concern. In 2007, China successfully demonstrated a kinetic anti-satellite weapon that confirmed for the world its capability to contest the space commons. China has outlined a strategic objective to stimulate commercial space activity, but has not yet developed the legal and regulatory structure to support this goal. Israeli space activities remain dominated by state-owned companies, but there are a number of small component manufacturers and entrepreneurs seeking venture capital. India is investing heavily in its space programs and assets, and has major ambitions in the commercial space arena.

U.S. Space Industry Today

Today, the U.S. is the leader in global space industry.[15] While there were no reliable data on profitability, the commanding lead in market share and revenues provide positive signs that the U.S. space industry is relatively healthy. Despite its export control burdens, the U.S. commercial space industry, which includes U.S. Government contracts, is the clear leader, followed by Europe. During 2009, the U.S. Government, along with international governments, spent an estimated $86.17 billion, accounting for 33 percent of the world space economy. Excluding stimulus funding, the U.S. government spending on space totaled $63.19 billion during FY 2009, a nine percent increase over the $57.98 billion budget for FY 2008. Government targeted space activities from the stimulus bill included $1.23 billion of funding that increased 2009 spending by 11 percent over FY 2008 budget figures. It is important to note the U.S. space industrial base is very dependent and tied to the defense market. One reliable source states, "60% of the industry's revenues are tied to national security…90-95% are tied to the U.S. Government."[16]

The U.S. commercial launch sector has declined considerably in the last decade. From a high of 22 launches in 1998, the U.S. accounted for only four commercial launches in 2009.[17] The U.S. space industry has generally complained about the high cost of launching from U.S. sites as compared to overseas facilities. In a sector dominated by European entities, Orbital Sciences, which specializes in lower-cost launchers, is an exceptional example of a successful U.S. commercial launch provider.

U.S.-led space tourism, still in the experimentation stage, is on the verge of becoming a new commercial segment of the space industry. In December 2009, Virgin Galactic unveiled its SpaceShip Two, being developed by Scaled Composites.[18] Months earlier, XCOR announced its two-seat, Lynx suborbital rocket plane. Both promise suborbital space trips in the future.[19]

Fueled by a globally increasing demand for satellite services, the overall condition of the space industry is healthy. In recent years, companies such as SpaceX have challenged the established space community, seeking to make space more accessible and affordable.

Innovations in satellite manufacturing at companies like Surrey Satellite Technology Limited are making satellites more affordable and more responsive to evolving customer needs. Finally, the optimistic innovations at Scaled Composites and XCOR promise space tourism as a new sector of the industry in the not too distant future.

CHALLENGES

The U.S. space industry faces challenges, which are neither insignificant nor insurmountable. Globalized competition, restrictive international trade policies, an endangered domestic industrial base, and an increasingly crowded operational space environment increasingly challenge America's unfettered access to space. The four challenge areas highlighted below captured the attention of the 2010 Space Industry Study Seminar.

International Traffic in Arms Regulations

While the International Traffic in Arms Regulations (ITAR) support the U.S. national security objective of limiting the proliferation of militarily useful technologies to non-U.S. persons, the current regulations have proven to be increasingly costly to our national security interests in space operations. They have a negative effect on the health of the U.S. space industry, on space-related research and development, and on international space industry cooperation. Since the U.S. Congress applied ITAR to advanced communication satellites and related technologies, the U.S. space industry has experienced steady erosion in its international competitiveness, evidenced by declining overseas sales revenue. The reduction in foreign sales has resulted in the industry, and particularly its second and third tier suppliers, becoming increasingly reliant on government contracts. This constrained revenue stream is slowing vital and innovative research and development (R&D) within the space industry. Unless the U.S. Government takes steps to reform the ITAR, the U.S. space industrial base will find itself increasingly uncompetitive internationally, constrained in its efforts to pursue R&D, and remain at risk in tapping promising human capital, which ultimately places U.S. leadership in space in jeopardy.

U.S. Space Industrial Base

The Space Industrial Base (SIB) is crucial to the security and economy of the U. S. It is a vital infrastructure that delivers high-technology capabilities the nation clearly cannot afford to be without. Currently, industry experts consider the U.S. SIB to be in good health, particularly at the larger, space prime contractor (first tier) level; however, both the Air Force and prime national security space contractors have raised concerns about the viability and performance of the sub-prime (second and third tier) companies within the SIB.[20] These lower tier companies play a vital role by providing subassemblies and critical components to first tier companies and are also responsible for a large portion of innovation and independent research and development in their respective product lines. Furthermore, lower tier space companies are typically small concerns who tend to be more vulnerable to the recent global business contraction, and are negatively affected by the ITAR-related barriers to competition in foreign space markets. These lower tier companies are most impacted by the recent instability of the U.S. Government's space program and what is becoming the most significant concern of the DoD space stakeholders in ensuring viability of the SIB.[21]

The Secretary of the U.S. Air Force, as the DoD Executive Agent for Space, and the Director, National Reconnaissance Office are taking aggressive action, through the Space Industrial Base Council (SIBC), to address some of the issues affecting the sub-prime level of the national security space industrial base. The SIBC is currently taking action to mitigate the impact to sub-prime companies when it is evident there is a significant national security industrial base issue that requires government intervention.[22] In certain cases, using the Defense Production Act of 1950, Title III, Congress has appropriated funding for critical technologies instrumental to national security.[23] Additional actions to protect the SIB include bulk procurement and using government personnel to document production processes of companies going out of business. In the area of critical components, immediate government intervention is taking place in the following areas: Mercury Cadmium Telluride Detectors, Cadmium Zinc Telluride Substrates, Visible Sensors for Star Trackers, Scaleable Accuracy Star Trackers, Read-out Integrated Circuits, High Reliability Space Qualified Diodes, and Rayon Replacement.[24]

Orbital Debris

America's access to space is threatened. Indeed, all space-faring nations' access to space is threatened by refuse from past space operations, orbital traffic accidents between spacecraft, and resultant debris from nefarious anti-satellite weapon demonstrations. "Orbital debris poses a risk to continued reliable use of space-based services and operations and to the safety of persons and property in space and on Earth."[25]

NASA's Orbital Debris Program Office defines space debris as "any man-made object in orbit about the Earth which no longer serves a useful purpose."[26] These objects consist of everything from spent rocket stages and defunct satellites to explosion and collision fragments. According to NASA, approximately 19,000 objects larger than ten centimeters (cm) are known to exist. The estimated population of smaller particles exceeds tens of millions.[27]

Space systems are fragile. Modest damage to critical satellite subsystems, such as solar arrays, may be catastrophic to the entire satellite. Space debris may travel at speeds of 7.8 kilometers per second in low earth orbit, "where a piece of debris the size of a marble could strike a satellite with approximately the same energy as a one-ton safe dropped from a five-story building."[28] On manned spacecraft, the threat of loss of life from space debris is real. NASA considers a catastrophic impact with large debris the number one threat to shuttle operations on every mission.

No technologies exist to remove debris from space, so for the foreseeable future, space operators must minimize additional debris and increase situational awareness to reduce collision hazards. Future U.S. space policy must continue to address this issue and the U.S., in collaboration with other nations, must improve Space Situational Awareness (SSA) capabilities and increase data sharing to minimize the possibility of accidents leading to increased debris fields.

U.S. Space Launch Industry

Today, the U.S. is meeting its launch requirements; however, there is some doubt in government and industry about the future of the U.S. space launch industry. The rising costs of launch, spurred by shrinking demand, a large foreign presence in the industry, and the lack of technological breakthroughs are the primary reasons for this concern. Secondary reasons are the high barriers to entry into the industry and regulatory restrictions that inhibit companies from exploiting global opportunities. Historically, the U.S. government has been the driver of

innovation and development within the launch industry. Unfortunately, economic constraints and a lack of vision over the past several decades have slowly eroded the launch industry. Recent comments by President Obama suggest the U.S. will shift to a reliance on the commercial sector for launch vehicle development.[29] This new direction raises concern. The commercial launch sector is gaining in capability, but it is still years away from meeting the nation's demand for reliable launch vehicles across the spectrum of lift requirements. There is little doubt that as the government removes itself from leading the effort in launch capability, the commercial sector will step in and try to fill the void. The question remains as to whether in this period of low demand, rising costs, over-regulation and fiscal constraints, the commercial launch sector can be viable and profitable over the long-term.

OUTLOOK

The U.S., and increasingly the rest of the world, relies on space-based capabilities to support global commerce and communications, national security, and military might. Today, the space industry is a vibrant and expanding global enterprise. While many industry sectors continued to suffer through a global economic crisis, a growing and diverse market for space-based products and services insulated the industry during the economic downturn in 2008 and 2009. Citing the fact that space companies continued to invest in new technologies and capabilities during the downturn, many analysts agree that the industry will only continue to strengthen as the economy improves. While government spending has historically been the foundation of the industry, increasingly, commercial space activities will supplant and possibly surpass government investment in some sectors. Futron Corporation's 2009 Space Competitiveness Index confirms that the U.S. remains the leading space participant, but its advantage continues to narrow as other nations improve their space capabilities.[30] The demand for space-based capabilities will continue to draw new market entrants as nations realize the value of space programs. This increased activity around the globe carries a potential for increased collaboration, to the benefit of all participants.

As the ICAF 2010 Space Industry Study Seminar concluded its work, Seminar members generally agreed that the outlook for the industry, in the U.S. and globally, is optimistic. The industry will face challenges caused by cyclic demand for satellites, but increasing demand for space-based services will sustain it. The succeeding paragraphs provide a synopsis of the outlook for three areas of particular interest to this year's Study Seminar.

An Educated Workforce

The availability of an educated workforce is critical to the sustainment of a highly technical space industry. In the U.S., the average aerospace employee age is 45, and 20 percent of aerospace industry researchers, engineers, and scientists are eligible for retirement within the next three years.[31] For the past several years, education experts have reported a steady decline of Americans pursuing science, technology, engineering and mathematics (STEM) degrees, yet many studies show the overall number of STEM degrees awarded to be increasing. However, the gain is limited to foreign-born students pursuing degrees in the U.S. Immigration and security laws will prevent many of these students from seeking employment in the U.S. space industry. Unlike many other fields, the U.S. space industry generally requires U.S. citizenship and a security clearance.

Among U.S. students in STEM programs, there is a general lack of space industry interest, with students preferring degrees in biotechnology or computer science. Several issues

with primary and secondary education contribute to this lack of interest. Many math and science teachers in the middle and high school lack degrees in these areas. According to the 2009 Space Report, "in 2000, nearly 70% of students were taught mathematics by teachers who did not major in the field and lacked certification."[32] Consequently, these teachers may be less enthusiastic about the math and science fields and potentially less likely to encourage or inspire students to pursue these fields.

While the outlook is not bright, the decline of American, STEM-educated students is not yet a crisis. Several ICAF Space Industry Study Seminar visits to U.S. Government agencies and commercial space companies confirmed that the industry sees potential problems in the future, but currently they are able to recruit and retain a well-educated American workforce.[33] To prevent a future crisis, both government and industry must collaborate to change this negative trend.

Manned Space

The outlook for the U.S. manned space program is less than optimistic and suffers from a 15-year lack of strategic foresight. Despite acknowledgment that the space shuttle program was aging and it had suffered two catastrophic accidents, the U.S. failed to put talent and resources toward a viable replacement in time to transition to a new spacecraft. As a result, there will be a gap of perhaps seven to ten years until a new manned U.S. spacecraft is available after the space shuttle is retired in 2010.

Both the Augustine Report and the FY 2011 budget plan are optimistic about the commercial sector's capability, relying on the "burgeoning" commercial space industry to provide U.S. manned access to space. It is difficult to believe, however, that this nascent industry could develop, rapidly and safely, a man-rated vehicle faster than NASA's Ares I, which has already had a test launch. This is not to say that commercial capabilities should not be part of the future vision. In fact, commercial services are an absolute must in the long term for basic services, a sound industrial base, and to reduce the load on government.[34] However, in the near future, safe and reliable manned space requires national means. The President's budget provides new funding for unmanned exploration and funding to assist the commercial sector in developing man-rated spacecraft. NASA has the innovative talent to advance manned space toward exploration of asteroids, the moon or beyond, but it requires a consistent strategy and stable resources.

The future of manned space depends on a strong vision and U.S. leadership. The Administration must provide clear policy on manned-space and an implementation strategy for achieving policy goals.

Exploitation of Space

Today, for large segments of the space industry, the private sector looks to the government for funding and direction. Historically, the government has focused on defense spending and government sponsored exploration. The key to a healthy and robust U.S. space industry lies in incentivizing the private sector to invest resources in space while at the same time convincing the American taxpayer that space exploitation is a worthwhile undertaking at the national level. Until now, the U.S. space industry has largely focused on using space to improve terrestrial capabilities, communications and remote sensing being the most prominent, and space exploration. Space exploitation offers many more possibilities. The potential harvest includes space manufacturing and technological advancement, lunar and planetary mining, space-based

solar energy, and space tourism and travel. The good news is that private industry is not standing still despite all the challenges. Space tourism in the form of Virgin Galactic is proceeding unabated. Pacific Gas & Electric in California has signed a contract to buy power from an ambitious start-up, Solaren Corporation, which plans to launch solar power collectors into orbit and beam energy back to Earth as radio waves.[35] Numerous other proposals exist to take advantage of the economic potential that exists in the outer reaches of space. With inspired leadership, the U.S. can maintain its lead in space with an appeal to the American entrepreneurial spirit and capitalist incentive.

GOVERNMENT GOALS AND ROLE

In the U.S., the government's role in space flows from the Constitution, particularly as it pertains to the nation's common defense, general welfare and military capabilities, but also as it pertains to foreign commerce. Domestic and international laws, treaties, and agreements also influence the role of government.

U.S. Space Policy is perhaps the most publicly visible role of government pertaining to U.S. space operations, assets, and business. President Dwight D. Eisenhower established the initial U.S. Space Policy and subsequently each president from Jimmy Carter to George W. Bush has published space policies. Several basic space policy tenets have remained constant since the early days of the space age and remain uncontroversial, such as the commitment to explore and use space for peaceful purposes, the rejection of claims of sovereignty in space, the importance of scientific discovery, and the desirability of international cooperation.

As of the date of this publication, the Obama Administration has not published a space policy; however, on April 15, 2010, in a speech delivered to NASA at the Kennedy Space Center, President Obama did outline his priorities for future U.S. human space flight. According to the White House Office of Science and Technology Policy, the President's policy "means more money for NASA, more jobs for the country, more astronaut time in space, and more investments in innovation. It will result in a longer operating lifetime for the ISS, new launch capabilities becoming available sooner, and a fundamentally more ambitious space strategy to take us to an increased number of destinations and to new frontiers in space."[36] Additionally, the President's commitment to the ISS is a significant step toward maintaining U.S. leadership in space. The Space Industry Study Seminar generally agrees with this assessment but is concerned that in the near-term, the U.S. must rely on foreign, and new and unproven commercial sources, such as SpaceX, for manned access to space.

Still, the President's vision for human space flight is only a single element of a very large and complex interrelated domain of civil, national security, and commercial activities. In order to clearly articulate to the American people, who will bear the costs of assuring access, and to the various agencies, industries, and Services who must collaborate to ensure continued access to space and global leadership in that domain, the Administration should develop a comprehensive space policy accompanied by a strategy for its execution. Study Seminar members agreed on the value of maintaining space policy goals generally consistent with those published in the past. Specifically, the policy must lead to the assurance that space capabilities are available when needed to support U.S. national security requirements and foreign policy objectives.

Beyond policy and beyond the single realm of the executive branch, the U.S. Government must develop a strategy for the execution of its space policy. While space policy will provide unifying principles and goals, the strategy must direct action. The strategy must be informed by

national security requirements and resource constraints and it must ensure fiscal stability for critical space programs. Annually, or as necessary, it must be adjusted to reflect current day realities and direct appropriate actions. The Study Seminar participants agreed that today, the key elements of a strategy are to provide a reliable U.S. based launch capability, to review export controls such as ITAR, and remove unneeded barriers to international trade in order to facilitate U.S. comparative advantage on the global market. Where global sources of supply and technology are uncertain, the strategy must also ensure the viability of the domestic industrial base. The strategy must consider the health of space assets aloft and space infrastructure on earth to ensure that neither capability degrades without timely replacement. Finally, the strategy must be mindful of the dangers caused by an increasing number of vehicles in an increasingly crowded space domain, and of the very real dangers presented by orbital debris. The space strategy must ensure that the U.S. can accurately detect and track space traffic, including debris, in order to avoid potentially devastating collisions that would further contaminate space.

ESSAYS ON MAJOR ISSUES

ESSAY 1: New Directions for Manned Space

This is an interesting year in the space industry, especially for the manned space sector. The vision set by President Bush in 2004 seemed straightforward: to develop a manned space program that will return the U.S. to the moon, Mars and beyond starting in 2020.[37] One expected that this vision would spur innovation within NASA, encourage commercial engagement in manned space, and provide U.S. citizens with nationalistic pride that had begun to wane after 30 years of the Space Shuttle program. Yet, five years later, a report commissioned by President Obama and led by Norm Augustine, found Constellation, NASA's manned space program, un-executable. The report, coupled with the President's 2011 budget submission, altered the course of U.S. manned space flight for the foreseeable future.

The Augustine Commission concluded that the government had never funded Constellation adequately to ensure its success. The commission's report included several recommended alternatives: extension of the ISS through 2020, extension of the space shuttle (limited to the safe fly-out of its current manifest), development of a heavy lift launcher, increased funding for technology, and use of commercial delivery of crews to Low Earth Orbit (LEO).[38] The recommendations came with a price tag of an additional three billion dollars per year, and even if the Constellation program hit its timetable, there would still be a gap in U.S. manned space flight of at least seven years between the retirement of the Space Shuttle in 2010 and the beginning of this revised Constellation program.[39] In February 2010, having reviewed the commission's finding and recommendations, President Obama submitted his FY 2011 budget to Congress. Surprisingly, he called for an increase of six billion dollars in NASA's budget over the next five years.[40] However, much to the dismay of his space constituents, he also called for the cancellation of the Constellation program. His vision was to incentivize the commercial production of manned space vehicles. NASA would then contract for these vehicles to send U.S. astronauts into space.

Both the Augustine Report and the President's vision rely on a future of commercially developed manned space flight capabilities to keep Americans in space. President Obama's budget proposes $500 million to contract with industry to provide astronaut transportation to the ISS, reducing the reliance on foreign crew transports and catalyzing new businesses and new

jobs.[41] Is the commercial sector willing? According to Elon Musk of SpaceX, they are not only willing, but also ready to accept the challenge. Musk feels SpaceX will succeed because, "Our internal timeline says we can do human spaceflight in two years because of all the work we have put into ensuring that Falcon 9 and the cargo version of Dragon are in compliance with NASA human-rating standards."[42] Likewise, Burt Rutan, one of the nation's most innovative aerospace designers, sees potential for commercial advancements with his Virgin Atlantic Spaceship 2 for sub-orbital space tourism. Rutan notes, however, that while commercializing suborbital flight is achievable, there are no safe solutions yet for commercialized orbital flight.[43] Given enough time and money, the spirit and innovation of the U.S. commercial sector could meet this challenge, yet to suddenly saddle the future of U.S. manned space onto a yet unproven industry is extremely risky.

It also appears the American people are willing to continue to gamble on the benefits of manned space programs. Findings in a 2008 Gallup Poll and a January 2009 survey by the Coalition for Space Exploration indicate that 71 percent and 88 percent of Americans respectively, support the space program and believe the U.S. is maintaining its leadership role in space exploration.[44] [45] Sixty-nine percent of those polled believe the space program benefits the economy.[46] Additionally, about three-quarters of Americans believe the space program is a valuable source of technological innovation and half of those polled would support a budget increase for NASA from 0.6 percent of the federal budget to one percent (FY 08 percentages).[47] With a commercial sector willing to gamble on the risky business of space and a population still willing to support it, which direction should the U.S. take?

The Augustine Report and the President's budget sought to balance manned space capabilities, exploration, and the commercialization of those capabilities against the realities of congressional, international, and financial influences. This balancing act results in a shift away from the advantage the U.S. has always held in manned space and may result in a decrease in space leadership. Instead, the U.S. should retain it leadership role by closing the manned space gap; it should support the extension of the ISS, shoring up the space industrial base, and giving time for commercial space to catch up. President Obama's budget indicates where he believes manned space fits on the continuum of issues the nation faces. Restructuring of the Constellation program and an increase in the NASA budget, which the President has already shown a willingness to do, should provide the budgetary means NASA needs for the following proposal.

First, extend the Space Shuttle program until 2015, safety permitting, to enable the U.S. to control its own destiny. Second, fund NASA to continue development of the Ares I rocket and Orion crew capsule; not to explore deep space, or to go to Mars, but to revitalize America's ability to launch its own astronauts. The continued use of the shuttle and development of Ares I ensure continued U.S. leadership in space.

Third, utilizing President Obama's proposed subsidies, the commercial sector should simultaneously develop its own version of a manned vehicle. Develop private-public partnerships to maximize the expertise available and to share ideas. This should not be a race for space as we have seen in the past, but a synergistic exercise to accomplish an end state. Space exploration is getting ever more expensive, operating in stovepipes is no longer a viable option. It must be "politically acceptable to the iron triangle of the space-industrial complex (industry, NASA, and the space patrons of Congress),[48] working together to further innovation, technology and education to inspire the next generation, who apparently still look to space with awe.

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ESSAY 2: U.S. Space Launch

A viable launch industry is the first critical element in maintaining assured access to space. Currently, there is a serious question as to whether this element of the U.S. industry will remain viable. The U.S. Government has historically provided the impetus for innovation and technology development within the space launch industry. Unfortunately, economic constraints and a lack of vision for several decades have led to the slow erosion of the launch industry.

President Obama recently announced his vision and guidance for future space operations. Most significantly, his direction shifts launcher development and operations away from direct government sponsorship toward commercial development, with some governmental support and oversight. The Administration expects this shift to reduce the costs of launch as commercial developers are more profit-driven and quickly develop innovative new technologies and manufacturing advancements to increase launch capability and availability.

Government regulations and oversight have hampered the enthusiasm within the launch industry. Based on our discussions with domestic companies, there is strong interest in collaborating with the government and in pursuing commercial opportunities that are profitable and viable for the long term. There is less enthusiasm where government oversight and regulation play a major part in the equation. Commercial human spaceflight is a perfect example where there is only tepid interest as the regulations governing manned flight number in the thousands.

Another factor influencing the U.S. launch industry comes from beyond national borders. Some believe that the U.S. has already lost its lead in the launch business because of foreign governments and companies providing launch services well below the cost of the U.S. launch providers while still maintaining the high reliability rates demanded by customers. On the commercial side, U.S. manufactured launch vehicle providers earned roughly 17 percent of the commercial launch market compared to 42 percent for Russia, 21 percent for Europe and 18 percent for the multinational company Sea Launch for the years 2004-2008. This is a three percent decline in market share from 2000 and the future market appears rather flat, indicating U.S. launch providers will not be able to count on growth in the global market to increase their market share. U.S. Government launch rates have also declined over the years. In the mid to late 1990s, government launches averaged 22.6 launches per year. Since 2001, that average has dropped to 15 launches per year and projections are that launches at this rate will continue into the next decade.[49]

As launch rates decline, competitiveness for launch customers increases and who wins these competitions has a direct impact on the health of the U.S. space launch industry. If U.S. companies are not more competitive and better at winning the business than their foreign competitors, the U.S. launch industry will not improve. Many foreign launch competitors are heavily subsidized by their governments, providing them considerable competitive advantage. In addition, U.S. companies find they cannot compete with the government for slots on the launch range so they are going outside the country for their launch services. Satellite owners will continue to purchase launch services from foreign companies until U.S. launch costs, space range flexibility and availability improve. The question remains as to whether in this period of low to flat demand, rising costs, over-regulation, and fiscal constraint, the commercial companies can be viable and profitable over the long-term.

The current Administration appears to be taking steps in the right direction. On April 20, 2010, Secretary Robert Gates proposed a game-changing reform of the U.S. Export Controls.[50]

Improving efficiency and streamlining the process to obtain a license, or no longer needing one at all, has the potential to open up markets and ultimately reduce the cost per kilogram to orbit. We believe that effective reform of export controls is essential to maintaining a viable launch industry and recommend that this Administration pursue reform as an important matter of national security.

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ESSAY 3: International Traffic in Arms Regulations: The Double Edged Sword

The ITAR are U.S. Government regulations that control the export and import of defense-related articles and services on the U. S. Munitions List (U.S.ML). These regulations implement the provisions of the Arms Export Control Act, and are described in Title 22 (Foreign Relations), Chapter I (Department of State), Subchapter M of the Code of Federal Regulations.[51] The Department of State interprets and enforces ITAR with the goal of safeguarding U.S. national security.

The ITAR support the U.S. national security objective of limiting proliferation of sensitive American military technologies, but the current ITAR regulations are also increasingly costly to our national security interest of assured access to space. "One major culprit is an overly broad definition of what should be subject to export classification and control."[52] These regulations are having an unintentional and negative effect on the health of the U.S. space industry, on space related research and development, and on U.S. and international space industry cooperation, to the detriment of the future U.S. defense posture in the space domain. Reforming the ITAR would protect our sensitive military technology and ensure the viability of our national space industry, which provides for our continued access to space as well as contributing to a strong national economy underpinning our national power.

Since the congressional action in 1998 to include advanced communication satellites under ITAR, the international market witnessed a significant rise in demand for satellites and supporting rockets fueled by a space service industry for television, radio, and mobile phone coverage in Africa, Asia, and the Middle East.[53] The Congress applied ITAR to all advanced communication satellites as the market started to expand to meet this new demand. Previously dominant in the satellite market, U.S. technology became more difficult to access leading to a negative ripple effect across U.S. space industry overseas sales. The Europeans invested in domestic sources of supply as the U.S. industry struggled to remain competitive.[54]

The ITAR's greatest impact on the U.S. space industry has been on the $123 billion commercial satellite business that had been growing at more than 10% a year for over a decade.[55] In 1998, U.S. firms accounted for 73% of the global market.[56] Two years after the imposition of the ITAR, the U.S. market share had been reduced to 27% of global demand.[57] Conversely, the European share of the market climbed from approximately 25% to more than 50%.[58] This represents a very significant market shift and is even more significant considering the market distortion resulting from the application of the ITAR to the U.S. product line.

Additionally, the ITAR have affected the launch and services sectors, evidenced by declining overseas revenue. American firms earned $304 million in revenues from launch services in 2003, but witnessed that figure decline to only $150 million four years later.[59] Conversely, European launch services revenue climbed from $178 million to $840 million

during the same period.[60] While there were certainly other factors involved in the declining U.S. market share and the rising European market share, such as European national flagship projects and European subsidies for research and development into domestically produced rockets, the market distortions resulting from ITAR were considerable.

Separate but related is the increasing challenge of pursuing collaborative research, with an open exchange of ideas, at the industry or university level between U.S. and foreign entities due to the restrictive nature of ITAR. The regulations control the transmission of sensitive technology to a Non-U.S. person just as tightly as exporting a material object to a foreign company. Consequently, research ventures and university projects must be extensively researched and approval sought ahead of time to ensure U.S. entities do not find themselves in contravention of the ITAR by permitting non-vetted nationalities access to sensitive science and technology. These constraints, as currently employed, often deny U.S. firms and universities access to the foreign-born talent that can help break the barriers of the next technological challenge rather than conceding this potential brain trust to foreign firms and governments at the expense of the U.S. goal to lead high technology science.

In order to remedy the ITAR, Congress should act on a five-point program. First, the management of the U.S.ML should be transferred from the Department of State to the Department of Commerce to reduce the number of federal departments with which U.S. firms must coordinate. This change also integrates the oversight function in a department that works extensively with U.S. corporations, trade associations, and is sensitized to real time business and economic interests.

Second, foreign availability of a technology should be a significant consideration when deciding on whether to remove items from the U.S.ML and dual-use technology list.[61] If the U.S. is not the sole source of the technology, unilateral U.S. restrictions may only serve to deny U.S. sales.

Third, a two-year sunset rule should be applied to all items on the U.S.ML and dual-use technology list.[62] Retaining an item should require recertification by the Department of Commerce. The sunset clause is a forcing function for the list to be reviewed on a bi-annual basis and thus recognize emerging changes in the technology market place.

Fourth, the review process should shift from a transaction-by-transaction approach to a trusted partner approach.[63] The Department of Commerce should establish a list of those countries and national companies meeting ITAR requirements. U.S. firms seeking business with pre-identified firms would not apply for approval, but provide notification of intent of sale so the Department of Commerce maintains visibility on technology flow. As new foreign companies comply with ITAR, they would be added to the list, making the list a “living” document rather than static in nature.

Lastly, the U.S. Senate should ratify the defense trade treaties with the United Kingdom and Australia.[64] These treaties would enhance collaboration with two strong U.S. Allies and significantly reduce the number of licensing requests currently in the process.

The U.S. has valid national security concerns in managing the transfer of sensitive military and dual-use technology overseas. Synchronized with this effort must be as rigorous a process to facilitate the U.S. space industry achieving competitive access to overseas markets if we are to see the industry resource robust research and development and provide the innovation required to sustain U.S. leadership in space.[65]

Author: COL Robert Cheatham, USA

ESSAY 4: Space Situational Awareness - Avoiding Orbital Debris

Operating in space is critical to the security of the U.S. The execution of national essential functions depends on the U.S. leadership's situational awareness and the capability to understand, communicate, direct, and adapt. Critical functions such as command, control, communications, and intelligence collection and dissemination enable and support those capabilities. Satellite-based systems enable all of those functions, either directly or as a contingency.

Other nations are also increasingly reliant on space operations for technical, military, and economic reasons. As they continue to increase their presence, orbital space is becoming a crowded place. This race into space also has the potential to create friction between nations, leading to the use of weaponry to destroy satellites or even space-based espionage satellites to spy on each other's satellites. More likely, crowded orbits will lead to increased traffic accidents between satellites. More than 50 years of debris from previous space operations and accidents are also crowded into orbital space threatening not only new orbiting satellites, but also manned spacecraft. As the orbits of these objects often overlap the trajectories of spacecraft, debris is a potential collision risk, and even the smallest particles may be catastrophic to fragile spacecraft. Even the smallest of debris striking a satellite at 17,000 miles an hour could and does have catastrophic results.

The loss of even one satellite can significantly degrade U.S. capabilities and infringe upon its ability to execute defense and other governmental missions. The loss of another nation's satellite due to collision can cause orbital debris that further threatens U.S. spacecraft. Reducing the likelihood of collision and of increased debris in orbit is in the United States' national interest, even if it means saving an adversary's satellite from destruction. Improved SSA is one means of reducing the risk of orbital collisions with other spacecraft or with space debris. SSA is "the ability to view, understand, and predict the physical location of natural and man-made material in orbit around the Earth, with the objective of avoiding collisions."[66] Timely situational awareness increases the probability of steering spacecraft clear of other spacecraft and orbital debris.

China's intentional destruction of the Fengyun-1C weather satellite in 2007 with an anti-satellite kinetic weapon created the largest single space debris incident in history, estimated to have created more than 2,300 pieces of trackable debris, over 35,000 pieces one centimeter (cm) or larger, and one million pieces 1 millimeter or larger.[67] In 2009, the accidental collision of U.S. and Russian communications satellites greatly increased the number of large debris in orbit. "The collision produced more than 800 pieces of debris larger than 10 cm in diameter...most of these debris fragments will be in orbit for decades, endangering more than 200 satellites."[68] These two incidents highlight the magnitude of the problem caused by single incidents. According to NASA, approximately 19,000 objects larger than ten centimeters are known to exist. The estimated population of particles between one and ten cm in diameter is approximately 500,000. The number of particles smaller than one cm probably exceeds tens of millions.[69] The U.S. has gaps in its SSA capabilities that prevent it from tracking even some of the most dangerous debris.

To overcome some of the SSA gaps, the U.S. has planned for over $2.3 billion of updates and improvements to its capabilities in the next five years.[70] Planned capabilities are highlighted by the "Space Fence" upgrade, and the "Space-Based Space Surveillance (SBSS)" system, each costing over $1 billion. The U.S., however, is not alone in space.

U.S. operations have become dependent upon the ability to transfer information globally to execute its global operations and cooperate with allies. While the most essential capabilities remain hosted on inherently U.S. space systems, utilization of commercial systems and partnerships with allies has changed the calculus of what constitutes "critical infrastructure." The U.S. Space Protection Program compiled a list of over 350 satellites deemed vital to U.S. operations, which "included a substantial number of civil and commercial satellites, as well as those operated by America's friends and allies."[71] As the U.S. increasingly leverages space partnerships with the commercial sector and partnering nations for telecommunications, imagery, and other space-based services, it has a greater need to ensure that its partners are successful. It also has a broader responsibility to ensure space operability for its commercial space industry and to help ensure it has the inherent core competencies to continue space operations.

Given the U.S. preeminence in SSA, and the extraordinary costs for SSA capabilities, the U.S. should consider SSA data a global service like the Global Positioning System (GPS), and share appropriate data with commercial and foreign partners for the mutual good of space utilization. Cooperative SSA can also be a beneficial situation for the U.S., as partnerships and cost sharing agreements can reduce respective resource burdens.

The U.S. Government has embraced cooperation in space and promoted the concept of security through space "inter-dependence" in the areas of navigation and communications. It should also apply space inter-dependence SSA, where everyone benefits by preventing additional space accidents and debris. SSA capabilities can also provide an understanding of the environment, including solar flares and space weather that can affect electronics on satellites, something of benefit to the entire space-faring community.[72]

International SSA cooperation with adversaries can be modeled after cooperation on the seas, where accepted guidelines create a cooperative environment without hindering national security-related capabilities. While cooperative SSA can benefit all parties, there needs to be better agreement on what SSA data can and should be shared with the rest of the space-faring community, especially adversaries.

Given the interdependence of all space faring nations' systems, international data sharing for SSA should become a priority. The U.S. should also share its SSA information with key U.S. commercial partners who provide the critical infrastructure through which the U.S. Government executes its critical missions. The U.S. should also share appropriate data with its adversaries to reduce the likelihood of accidental space collisions. Ensuring SSA information is available throughout the space-faring community will, in the long run, benefit all parties in keeping space operable.

Author: Mr. Gary Halton, DoD

ESSAY 5: United States Space Policy and Strategy

As a space-faring nation and global leader in that domain, the U.S. is heavily dependent on access to space for everything from Automated Teller Machine (ATM) transactions to national and military intelligence collection. The rest of the world is rapidly joining the U.S. in space. An increasing number of entities are now capable of accessing an increasingly crowded global space commons, and potentially hostile states are obtaining asymmetric space capabilities. These include the means to destroy or disrupt U.S. space-based assets. Therefore, the U.S. needs capabilities, including multilateral alliances, to assure access to space and to protect the critical assets already in orbit.

Retaining or enhancing these space capabilities and systems will not be cheap. The growing U.S. debt and annual spending deficit will likely force funding decisions that could negatively affect national security interests. In order to secure continued access to space, the Administration must develop a national space policy focused on the critical national security interest of assured access. The Administration should then publish a resource-informed strategy for achieving its policy objectives.

In July 2009, President Obama ordered a sweeping review of U.S. space policy, the results of which are not yet publicly available. The National Security Presidential Directive on space policy, released in 2006, is the most recent U.S. policy. It is generally consistent with those put forth by presidents since Dwight D. Eisenhower. Though less tolerant of nations and activities that would in any way restrict U.S. access, it clearly articulated the importance of space to national security, economic well-being, and technological advancement and it recognized that space is a commons of growing competition, challenge, and opportunity. Given the aforementioned national security priority of maintaining assured access to space, and in light of well-established, as well as emerging, threats and vulnerabilities, the following are this author's space policy recommendations.

Access to space is important to an increasing number of states. The U.S. should seek to integrate its space capabilities with those of other nations who share an interest in maintaining open access to space. This integration could allow the U.S. to leverage other-nation capabilities, as either a substitute or enhancement for U.S. capabilities. By encouraging those nations to contribute to the development of U.S. capabilities, the U.S. can more easily align their interests with its own. In concert with this initiative, the U.S. should undergo a complete review of critical space technologies to modernize its export control process in order to facilitate trade and cooperation with partners and allies while keeping sensitive technologies out of the wrong hands.

The U.S. will require the ability to deny adversaries the use of space for hostile purposes during armed conflict. Several tools exist to enable the capability, but given the example of a China's demonstration of a kinetic kill of an orbiting satellite and the ensuing debris field, U.S. policy should favor capabilities that do not create further obstacles. Diplomacy and sanctions have proven to be effective tools. For example, during Desert Storm, the U.S. collaborated with other space allies to deny Iraq the use of certain space capabilities. Ground-based space facilities are relatively easy to locate and they provide potential targets for both soft and hard kill technologies, should diplomatic actions be insufficient. Kinetic kill of adversary spacecraft should be the last option, if an option at all.

U.S. policy must address protection of space assets. In space, damage to subcomponents of a satellite can render the entire expensive system unable to perform its mission with no means to repair or recover it. Space policy should encourage the development of satellite systems that utilize a networked architecture of plug-and-play nodes where the loss of a node would not mean the loss of an entire capability. The space policy must also address the responsiveness of the U.S. space infrastructure. Launch facilities and satellite manufacturing must support emerging and surge capabilities. They need to be modernized, both in infrastructure and in management practices, in order to become competitive on the global market. Programs like Operationally Responsive Space, which emphasize control of costs and responsiveness to operational requirements, should be central to the U.S. space program.[73]

Space debris is a man-made tragedy that could threaten access to space. Strong leadership can make a difference. The U.S. space policy should direct diplomatic initiatives to build upon the standards set by NASA in 1995 for debris mitigation and share them through

multilateral agreements and treaties with international partners. The U.S. should lead the establishment of an international coalition of the dominant space launch entities (Russia, China, European Space Agency, Japan, and India) to share information to reduce debris and require that payload providers demonstrate that they meet acceptable standards before launch.

Because a collision in space can result in catastrophic loss, it is in the interest of all nations who utilize the space commons to contribute to the improvement of technologies like the U.S. Space Surveillance Network (SSN) that improve space situational awareness.[74] A policy of collaboration in this realm carries the risk of revealing sensitive details about U.S. space capabilities and activities, but the benefits of reducing the probability of collision, may outweigh the risks.

Finally, the space policy should reaffirm the importance of U.S. leadership in space, but it should do so with full awareness that space is contested more now than ever in the past. The policy must place emphasis on the importance of international collaboration on science and other non-threatening space activities, and in so doing, it should reaffirm national commitment to the ISS.

Development of policy is just the first step. A strategy to achieve policy goals is the next and most important step. A 2008 Government Accountability Office report cited the Director of the National Security Space Office and the Director of Space Policy in the Office of the Under Secretary of Defense for Policy as believing a strategy is necessary to provide analysis and higher level strategic guidance to influence investment.[75] Lieutenant General John Sheridan, Commander of the Space and Missile Systems Center, remarked: "...an official national space strategy [will] ensure that policy gets translated into programs."[76] A national space strategy will describe how the nation will use its political, military, commercial, and financial resources to accomplish the goals set forth in the space policy. A strategy will provide the direction and framework for unifying the efforts of defense, intelligence, civil and commercial space activities to accomplish national security objectives. It will provide the foundation for making complex technological and resource decisions and it will inhibit competition between agencies for scarce resources by clearly defining responsibilities, relationships and investment priorities. A national space strategy will facilitate a coordinated national space program, supported by stable and adequate funding, and programmatic stability, in order to avoid costly disruptions in execution.[77] As opposed to the space policy, which has remained nearly unchanged for more than fifty years, a space strategy should be a dynamic document, responsive to changes in domestic and global conditions, ensuring that the U. S. prioritizes investment decisions against available resources.

The continuation of U.S. leadership in space begins with leadership on Earth. A responsible and balanced space policy and strategy will exemplify that leadership.

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CONCLUSION AND RECOMMENDATIONS

As a vital element of U.S. national security, space activities provide the nation with unique capabilities for national and military intelligence, precision navigation, global communications and financial transactions, and entertainment. As the leading global space faring nation, the U.S. depends on the use of space more than any other nation. This study began with generally agreed upon beliefs by the Study Seminar members that the space industry, at least in the U.S., was in trouble, suffering a malaise caused by lack of direction, unstable

funding, and aging infrastructure. After extensive consultation with U.S. and European government and industry space experts in all segments of the space industry and as a result of individual research, the 2010 ICAF Industry Study Seminar concludes that the space industry is healthy, even vibrant in some sectors, and a critical component of the global economy. As noted throughout this paper, the industry is not without challenges, but none are insurmountable if given the resources and leadership deserving of a vital national security capability. Accordingly, we provide the following recommendations for action needed in the near-term to assure continued U.S. access to space.

Recommendation to Develop a National Policy and Implementation Strategy for U.S. Space Activities. A policy should define priorities, guide planning and programs, and direct actions. A national space strategy will describe how the nation will use its political, military, commercial, and financial resources to accomplish the goals set forth in the space policy. The recommended policy goals are:

- to ensure that space capabilities are available when needed to support U.S. national security requirements and foreign policy objectives;
- to enable a globally competitive domestic commercial space industry to foster innovation and contribute to national security objectives and economic security and prosperity;
- protect and enhance U.S. space assets, specifically launch infrastructure modernization;
- enhance understanding of the universe, the solar system and the Earth through robotic exploration;
- to prepare for eventual human exploration in space as technologies mature;
- to rapidly extend benefits derived from space operations to the American people;
- to actively encourage and incentivize international cooperation in all elements of space where such activities promote the peaceful use of space, are of mutual benefit to participants, and further U.S. national security and foreign policy object;
- direct diplomatic initiatives to build upon the standards set by NASA in 1995 for debris creation and share them through multilateral agreements and treaties with international partners;
- increase international collaboration in Space Situational Awareness to reduce operational risk.

The recommended near-term implementation strategy priorities are:

- provide a reliable U.S. based launch capability;
- to review export controls such as ITAR and remove unneeded barriers to international trade;
- consider the health of space assets aloft and space infrastructure on earth to ensure that neither capability degrades without timely replacement;
- ensure that the U.S. can accurately detect and track space traffic, including debris, in order to avoid potentially devastating collisions that would further contaminate space.

Recommendation to Reform the International Traffic in Arms Regulations. The ITAR support the U.S. national security objective of limiting proliferation of sensitive American military technologies, but the current ITAR regulations are also increasingly costly to our national security interest of assured access to space. In order to remedy the ITAR, Congress should act on a five-point program.

- Transfer the management of the U.S.ML from the Department of State to the Department of Commerce to reduce the number of federal departments with which U.S. firms must coordinate.
- Foreign availability of a technology should be a significant consideration when deciding on whether to remove items from the U.S.ML and dual-use technology list.
- Apply a two-year sunset rule to all items on the U.S.ML and dual-use technology list.
- Shift the review process from a transaction-by-transaction approach to a trusted partner approach in order to streamline trade processes.
- The U.S. Senate should ratify the defense trade treaties with the United Kingdom and Australia. These treaties would enhance collaboration with two strong U.S. Allies and significantly reduce the number of licensing requests currently in the process.

While the recommendations presented above are few in number, it is the opinion of the Space Industry Study Seminar members, that action must be taken now to address each, in order to maintain the health of the industry and retain America's leadership role in space. Acting on these recommendations will not be easy because it will require collaboration and consensus among stakeholders with divergent views and agendas. Ultimately, it is the hope of the Space Industry Study members that all stakeholders will recognize the importance to the nation's security of a vibrant and growing space industry and act accordingly to secure its future.

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