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15.Abstract: Today, the United States is more dependent on space capabilities, both militarily and economically, than any other country in the world.[1] And, our dependence is growing at an exponential rate. However, just as with any leading edge technology or revolutionary capability, the cost is significant and budgets are limited. Consequently, it is critical that our space forces are properly prioritized, sized, and balanced with respect to national strategy and force planning to ensure we have the required capabilities to meet our national objectives.

Our dependence on space assets for national defense receives the vast majority of attention. However, American's are rapidly becoming more and more reliant on space systems as part of the nation's critical economic infrastructure, and most American's don't even realize it. Further, the vulnerability of U.S. space systems to enemy/terrorist attack is growing with the proliferation of technology, is also widely unknown, and represents a critical weakness in the U.S. economic infrastructure.

The purpose of this paper therefore, is to: 1) analyze our vital national economic interests and the strategic importance of our space capabilities; 2) demonstrate that current space forces are improperly programmed to fully meet their designated requirements in support of national interests; 3) demonstrate that the results of this deficiency could prove catastrophic; and 4) provide prescriptive solutions to rectify the "strategic gap" between national interests and space capabilities.

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U.S. Space Power:
The Achilles Heel of America's Economic Well-Being

By

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A paper submitted to the Provost, Naval War College, for the B. Franklin Reinauer II Defense Economics Prize essay competition.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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"National Strategy is the art of utilizing the resources of a nation, including its armed forces, to the end that its vital interests shall be effectively secured against its enemies."

Edward Mead Earle[2]

Introduction:

Today, the United States is more dependent on space capabilities, both militarily and economically, than any other country in the world.[3] And, our dependence is growing at an exponential rate. However, just as with any leading edge technology or revolutionary capability, the cost is significant and budgets are limited. Consequently, it is critical that our space forces are properly prioritized, sized, and balanced with respect to national strategy and force planning to ensure we have the required capabilities to meet our national objectives.

Our dependence on space assets for national defense receives the vast majority of attention. However, American's are rapidly becoming more and more reliant on space systems as part of the nation's critical economic infrastructure, and most American's don't even realize it. Further, the link between military space capabilities and commercial/civil capabilities is tightly interwoven. Military space capabilities not only provide the infrastructure to launch and control commercial satellites, but also to protect them through national defense capabilities such as counterspace missions. Unfortunately, the vulnerability of U.S. space systems to enemy/terrorist attack is growing with the proliferation of technology, and represents a critical weakness in defense capabilities...and consequently a critical threat to the U.S. economic infrastructure also.

The purpose of this paper therefore, is to: 1) analyze our vital national economic interests and the strategic importance of our space capabilities; 2) demonstrate that current space forces are improperly programmed to fully meet their designated requirements in support of national interests; 3) demonstrate that the results of this deficiency could prove catastrophic; and 4) provide prescriptive solutions to rectify the "strategic gap" between national interests and space capabilities.

Analytical Models:

In order to make explicit the critical link between U.S. space power and America's

economic well-being, and then plan an effective strategy, we will first turn to National Strategy and Force Planning. National Strategy and Force Planning are two of the most important roles of our government; an inviolate obligation to the American people. As stewards of public safety, trust, and taxpayer resources, our government is expected by its citizens to provide for our national interests in a fiscally responsible manner that optimizes the cost/benefit equation. Simply defined strategy is the linking of ends and means—a gameplan that tells how finite resources will be employed to achieve declared objectives.[4] Force planning is the military component of strategy that assesses security needs, identifies resulting military requirements, and establishes the proper mix of military forces to meet those requirements.[5]

There are a number of alternative approaches to force planning, from Top-down and Bottom-up, to Scenario and Threat/Vulnerability, to Fiscal and Technology approaches. Each places emphasis on different drivers, such as national interests, or existing capabilities, or specifically identifiable threats. But regardless of which approach is chosen, the Bartlett Doughnut[6] shown at Appendix A is a helpful model for understanding the dynamic interaction of key variables of the process. Bartlett depicts a continuous process without defining a specific "entrance point." As such, whether one chooses to start with identifying Goals/Ends (the Top-down approach), accepting Resource Constraints (Fiscal approach), focusing on existing Tools/Means (Bottom-Up approach), or begin the process based on current Risks (Threat/Vulnerability approach) this is a helpful model to facilitate force planning.

The institutional planning approach used by the U.S. Government is the Top-down approach. National interests and objectives drive force requirements. Specifically, the President lays out the National Security Strategy (NSS), the Department of Defense then develops the supporting National Military Strategy (NMS), the Services then develop specific supporting programs and capabilities, etc. The Lloyd Framework[7] at Appendix B was specifically created to assist decision makers operating within the current U.S. Top-down construct. It is designed to systematically lead decision makers through the process of

identifying interests, objectives, and strategies (top half of the model) ultimately yielding programmed forces (bottom half of the model). Lloyd argues that the Assessment phase serves as the link between strategy and force structure, and pays specific attention to the concept of Risk (a common theme to Bartlett's Doughnut) defined as a mismatch between desired ends (national security objectives) and the resources (planned forces) necessary to achieve those ends. Together, the Bartlett Doughnut and Lloyd Framework will be utilized to trace the translation of our national interests into strategies and then determine the effectiveness of the U.S. space program to meet those interests.

Identifying National Goals/Interests

"Defending our Nation against its enemies is the first and fundamental commitment of the Federal Government...The United States will build on common interests to promote global security...America will encourage the advancement of democracy and economic openness because these are the best foundations for domestic stability."

President George W. Bush, excerpts from 2002 NSS[8]

Bartlett calls them goals or ends, Lloyd calls them interests but both require the identification of our most critical needs and concerns. According to Donald Nuechterlein, basic consensus among political scientists and strategists suggests that U.S. national interests can consistently be viewed in terms of four broad categories: 1) Defense of the Homeland; 2) Economic Well-Being; 3) Favorable World Order; and 4) Promotion of Values. Nuechterlein further defines the first two as "vital" national interests, those that threaten a nation's very survival.[9] All four can be seen in the excerpt from the 2002 National Security Strategy (NSS) above. Today, U.S. space capabilities are critically linked, and absolutely vital, to ensuring Economic Well-Being. Space has become so important that it is now being referred to as a vital national interest in and of itself, in direct correlation with its impact on the U.S. economic infrastructure. President Clinton made this declaration in the 1999 NSS and it was affirmed verbatim in the U.S. Commission on National Security for the 21st Century (the Hart-Rudmann Commission):

"Unimpeded access to and use of space is a vital national interest—essential

for protecting U.S. national security, promoting our prosperity and *ensuring our economic well-being*."[10]

As Commander of U.S. Space Command, General Richard Myers, now Chairman of the JCS, made the same assertion:

"Space is not just a military, but also *an economic center of gravity*, a vital national interest."[11]

In the 2001 Annual Defense Review, Secretary of Defense Donald Rumsfeld added the exclamation point in stating:

"The ability of the U.S. to access and utilize space is a vital security interest because many of the activities conducted in space are critical to its national security *and economic well-being*."[12]

Consider the specific evidence.

Economic Well-Being

Commercial satellites facilitate banking and stock market transactions, control credit/debit card and ATM authorization networks, operate cellular telephone and pager networks, and control timing signals operating electric grids. There are an estimated 45 million cell phone and pager subscribers, and over 12 million credit/debit point-of-sale and ATM systems that rely daily on satellite communications.[13] Over 60% of all U.S. satellites are commercially operated, providing a staggering economic impact.[14] The U.S. commercial satellite business was estimated to be a $35 billion industry in 2000, and is projected to triple over the next decade.[15] Underscoring our critical dependence on space, and the magnitude of impact even minor disruptions can cause, are two concrete examples. In 1996 a satellite controller accidentally loaded a wrong variable into just one of the GPS constellation's 24 satellites. The erroneous variable was broadcast for only six seconds; nonetheless thousands of cell phones on the East Coast that rely on GPS timing signals failed for days.[16] In 1998, a U.S. commercial Galaxy IV satellite malfunctioned for an "unknown reason", shutting down more than 32 million U.S. pager customers and leaving 5,400 Chevron gas stations without pay-at-

the-pump capability.[17] In 1997, then Commander of U.S. Space Command, General Howell Estes asserted space had become an economic "center of gravity" for the U.S.,[18] and the Hart-Rudman Commission declared space critical not only to the U.S. domestic economic system, but the "main artery" of the evolving globalized economic world.[19]

Developing a Strategy for Space

The unimpeded access and use of space is clearly critical to achieving the U.S.'s vital national interest of securing our economic well-being. As such, both the Bartlett and Lloyd models would then have decision makers develop coherent, descending layers of supporting strategy down to the operational level, to protect and utilize space to achieve those interests. The Lloyd Framework takes special notice of the requirement to assess the current and future environments within which forces must be designed to operate.

Current and Future Environments

The current environment for U.S. space force planners is punctuated by two key themes. First, over the course of the last half-century, with very few exceptions, the U.S. has enjoyed a near monopoly in space. Only the former Soviet Union ever rivaled our capabilities, and even then only in a few specific areas such as satellite reconnaissance and manned space flight. Since the time of the famous "Man on the Moon" speech by President Kennedy the U.S. committed its national will to space superiority and has enjoyed the benefits of that undisputed superiority ever since. We currently operate over 300 active satellites, nearly half of all operational satellites in the world, and lead all nations in intelligence, surveillance, navigation, missile warning, and communications capabilities.[20] Secondly, the use of space was viewed from its infancy from a Liberalist/Idealist point of view. A series of international treaties and agreements, (e.g. the Outer Space Treaty of 1967 prohibiting nuclear weapons in space, the Anti-Ballistic Missile Treaty of 1972 prohibiting anti-satellite weapons) all deemed space a "safe-haven" and reserved it for peaceful uses. Neither the "U.S. superiority" theme, nor the "safe-haven" theme, is guaranteed to continue in the future.

With respect to U.S. superiority, today more than 20 countries possess space capabilities,[21] and with each additional space faring nation the capabilities gap between the U.S. and the rest of the world dwindles. International consortiums that cut across national lines, such as the European Space Agency, provide a synergistic pooling of resources that are now competing with U.S. companies for global market share of space leadership and technological superiority. The significant increase in the number of countries involved in space also presents a greater potential for tension as more nations vie for limited frequency and bandwidth allocations, and more and more interests are represented at international conferences. Although we still maintain superiority, it cannot be disputed that our lead is shrinking.

Additionally, the overall military superiority of the U.S. in general, and our unprecedented dependence on space has created a much more Realist-based environment with respect to space, and is testing the Liberalist "safe-haven" view to its limits. In *On War*, Clausewitz describes a center of gravity as "*the hub of all power and movement, on which everything depends. It is therefore a source of strength and at the same time a vulnerability requiring protection.*" In strategic thinking, dependence soon becomes a vulnerability and, by extension, a potential target. In the post-Cold War environment, it is undisputed that no military on earth can engage in direct combat activities with the U.S. and emerge victorious. Potential foes will attempt to use asymmetric warfare to blunt the full force of the U.S. military, and targeting our dependence on space would be an extremely successful way to do so. This point was illustrated when the Chinese Xinhua news agency reported in July 2000 that China's military is developing methods and strategies for defeating the U.S. military in a high-tech, space-based future war. It noted,

> "*for countries that could never win a war by using the method of tanks and planes, attacking the U.S. space system may be an irresistible and most tempting choice.*"[22]

Some critics might argue that this is an overly ominous and Machiavellian view of the world. They might point to international treaties and frameworks within which to settle space disputes, and that there has never been a documented case in which one nation attacked another nation's space systems. However, several key points need to be made. First, treaties have been violated since the beginning of recorded history. There are multiple treaties against weapons of mass destruction, yet they are being proliferated around the world. And when a nation believes their vital national interests are at stake, treaties will likely not prevent them from taking steps to ensure their survival. Second, because the majority of satellites cannot detect when they are being attacked, it is nearly impossible to differentiate an attack from natural phenomena such as solar flares. Therefore, there may not be any "documented" cases of nation-to-nation satellite attacks, but that doesn't mean they are not already occurring and cited as "unknown errors" (reference the Galaxy IV incident above.). Third, simply because nation-to-nation satellite attacks have not occurred to date (and perhaps they have) does not mean they will not occur in the future. Our national dependence on space-based systems equates to vulnerability, and history shows that vulnerabilities are eventually exploited by adversaries. Every medium, from land, to sea, to air, has been the source and stage of conflict as it grew in strategic importance, and space will likely be no different. Finally, it is also important to point out that in the post-9/11enrivonment, the strategic relevance of non-state actors is ever more important. Liotta's Chaos Strategy[23] argues we have entered a new security era in which attacks by non-state actors meant to induce fear and a sense of extreme vulnerability in the American psyche will increase. As will be discussed later, our satellite systems today are just as vulnerable to moderately financed terrorists as to states. Not just Realism, but reality itself, indicates that force planners must consider that space will not be a "safe-haven" forever.

Descending Layers of Strategy:

With a clear understanding of national interests (through the NSS) and the current and future environments for space, we can follow the development of descending layers of

strategy. *Joint Vision 2020* (JV2020), the Chairman of the JCS's guiding vision and strategic direction for the U.S. Armed Forces is centered on the concept of Full Spectrum Dominance.[24] In order to achieve Full Spectrum Dominance, JV2020 identifies four key Operational Concepts, or enabling capabilities: 1) Dominant Maneuver; 2) Precision Engagement; 3) Focused Logistics; and 4) Full Dimension Protection. As pointed out previously in the Defense of the Homeland discussion, Precision Engagement rests nearly completely on the foundation of GPS, and Full Dimension Protection includes both the National Missile Defense and Theater Missile Defense systems that are 100% dependent on DSP and SBIRS for initial missile detection. Dominant Maneuver and Focused Logistics are both heavily reliant on space systems that provide navigation, weather forecasts, reconnaissance, and especially communications relays.

To support JV2020 and Full Spectrum Dominance, the *U.S. Air Force 2003 Posture Statement* identified seven Key Task Forces, or core competencies, necessary to organize, train, and equip forces for the Combatant Commands: 1) Global Strike; 2) Homeland Security; 3) Global Mobility; 4) Space and C4ISR; 5) Global Response; 6) Nuclear Response; and 7) Air and Space Expeditionary. Clearly, space capabilities are core components of both the Space and C4ISR Task Force and the Air and Space Expeditionary Task Force. As evidenced by previous illustrations, navigation, weather, intelligence, reconnaissance, and communications provided by space systems are also key enabling capabilities to each of the other Task Forces as well. Specifically addressing the growing import of space, the *Posture Statement* identified "Exploiting Space for the Joint Warfighter" and "Pursuing Assured Access to Space" as its two dominant space requirements to meet present and future national security challenges.

To continue the waterfall of strategy, Air Force Space Command (AFSPC) developed the FY04 *Strategic Master Plan* (SMP). The SMP lays out the vision for AFSPC to develop, acquire, field, and sustain space systems and capabilities in support the Air Force's Key Task Forces, identifying four core mission areas: 1) Space Force Enhancement; 2) Counterspace; 3)

Space Force Application, and 4) Space Support. Space Force Enhancement focuses on capabilities that contribute to maximize the effectiveness of the military air, land, sea, and space operations. Counterspace provides capabilities to allow friendly forces unimpeded use of space while negating an adversary's ability to do the same. Space Force Application provides the capability to perform missions carried out by weapons systems operating from or through space for holding terrestrial targets and risk. Space Support provides the critical launch and satellite control infrastructure that enables all of the other mission areas to effectively perform their missions. Together, the programs and capabilities provided through these core mission areas are the sum total of space's contributions to national security. Developed as a direct result of descending, interdependent layers of strategy, it is this author's opinion they are sound and sufficiently coherent to effectively secure our national interests ... if properly programmed and executed.

Assessment of Forces/Tools

Once appropriate strategies have been selected, we move into the bottom half of both the Bartlett and Lloyd models. Bartlett and Lloyd both recognize the realities of fiscal resource constraints and how they significantly influence and alter the forces that are ultimately programmed and fielded. Therefore, both models next provide a mechanism whereby current forces and programs are evaluated to determine whether or not they are sufficient to meet the stated requirements they were designed to achieve. Of course, fiscal constraints are not the only influences that perturb the resource process. Organizational Behavior and Governmental/Politics perspectives such as Congressional constituencies, Service cultures, and the vast bureaucracy of the Pentagon also greatly influence the process. The Lloyd Framework includes an emphasis on identifying Threats, and Vulnerabilities. Clearly, assessment of our entire national space program is obviously an extremely complex and in-depth study, the details of which are far too voluminous for inclusion in this paper. However, in attempting to identify fiscal constraints, threats, and vulnerabilities, several broad themes do appear that bear significantly on this study and demand to be addressed.

Space Support: Critical Launch Infrastructure and Launch Operations

"We are all interested in Assured Access to Space. What we have today is neither assured access in many cases, nor responsive enough to the warfighter."

Integrated Defense Industry Study[25]

As previously defined, Space Support includes the critical launch infrastructure and launch operations capabilities that enable all of the other mission areas to be effectively performed. No space asset can perform its assigned mission, upon which all of the waterfall of previously discussed strategies are built, until they are successfully launched into precise orbits through safe and responsive launch operations. The reader will recall Launch Operations, referred to as Assured Access to Space, was singled out by the Air Force as one of its two dominant space requirements. The AFSPC SMP refers to Launch Operations as the "*foundation upon which all other mission areas are built*". In summary, the U.S. launch infrastructure and Launch Operations capabilities are critical vulnerabilities. They are fragile and vulnerable to attack, non-responsive to warfighter needs, and are excessively costly.

Fragile and Vulnerable Infrastructure: 100% of U.S. military satellites, and a majority of U.S. commercial satellites, are launched from only two launch sites; Cape Canaveral Air Force Station, Florida, and Vandenberg Air Force Base, California. Both launch bases date back to the beginning of the space age in the early 1950s and due to competing budget priorities have been neither standardized nor fully automated, while newer built foreign launch bases have.[26] This has both greatly increased the cost and decreased the flexibility of U.S. launch capabilities. In 1999, the number of launches in the queue at the Cape actually exceeded the base's launch capacity, and the on-orbit capability of important military satellites was unnecessarily delayed.[27] Some U.S. commercial satellite companies are now opting to launch overseas due to reduced costs and greatly flexibility with foreign launch services. Major upgrades and modifications have been scheduled, but have been plagued by competing funding priorities within the Air Force as evidenced by the $850 million cut to the program in the 2003 budget.[28] Neither can the two bases provide each other with back-up

capability. Due to the nature of the orbits of certain satellites and physical limitations of current rockets, polar-orbiting satellites can only be launched from Vandenberg, and equatorial satellites are only launched from the Cape. This means we have a single point failure with respect to our vital national requirement of Assured Access to Space. Attacks by a hostile government or a terrorist cell, or even natural phenomena such as a hurricane, could leave the U.S. from 50% to 100% incapable of launching satellites for many, many months.

Non-responsive to Warfighter and U.S. National Security Needs: The long launch preparation time (six to nine months) of expendable launch vehicles (ELVs) and size of satellites themselves (many the size of a greyhound bus) renders standard launch timetables cumbersome at the strategic level, and outright unacceptable at the tactical level of warfare. Many of our satellite constellations operate with limited or no spares, and replacing one, even in a national emergency, could take months or even years. As far back as 1992, the Commander of AFSPC said, "*our current launch vehicles and their associated processes do not provide the responsiveness needed to rapidly replace or augment on-orbit assets.*"[29] During the Falklands Conflict, the Soviet Union launched 29 satellites within 69 days, an extraordinary surge capability. In contrast, it took the U.S. 113 days to replace a defense weather satellite after an emergency call-up in 1995.[30] Recently, General Charles Horner recalled that when he was Commander of AFSPC, after one satellite sat on the launch pad at Cape Canaveral for nearly two years due to technical difficulty with the rocket he threatened to put a building number on it.[31] Clearly, this shortfall points to the need for a rapid-response spacelift system as a critical future capability.

Excessive Cost: Excessive cost is driving many U.S. commercial companies to launch overseas. In a spiraling effect, this leaves the military with an even greater share of the cost of running our launch bases. The Pentagon estimates it costs $10,000 to put one pound of payload into orbit with existing ELVs and the average cost of a military launch is $72 million.[32] Cost is so excessive, and profit so narrow, that one of Vandenberg's only two military launch contractors (Lockheed-Martin) closed their program leaving Boeing as

Vandenberg's sole military launch provider. This highlights another single point failure in our launch capability (if Boeing experienced a technical failure all military launches at Vandenberg would cease indefinitely) and perfectly demonstrates the critical vulnerability that cost has become. New technology reusable launch vehicles (RLVs) currently on the drawing board offer the promise of reducing launch costs by up to 90%[33], and were touted by Gen Ed Eberhart when he commanded AFSPC as "*key to conquering our space challenges.*"[34] Microsatellite technology would also significantly reduce weight and cost. Ironically, despite their potential of substantial savings in the long run, neither has been aggressively pursued due to lack of funding.[35]

Counterspace: Protection of Vital U.S. Space Systems

"One of the nation's most valuable forms of critical infrastructure is its space-based satellite constellation. It is also our most vulnerable. Nowhere else does our defense capability rest on such an insecure firmament?"

Hart-Rudmann Commission[36]

At the heart of the Counterspace mission is the ability to allow friendly forces to use space capabilities in accomplishing our military objectives, while preventing an enemy from taking those critical capabilities away from us. Built upon the foundation of successful Launch Operations (Space Support), the elements of Counterspace form the pillars upon which the sum total of on-orbit military space power rests. Just as denial of Launch Operations renders our future space capability impotent, the inability to perform our Counterspace mission would render our current space capabilities useless. Unfortunately, our critical on-orbit assets, both military and commercial, are critically vulnerable.

Military Systems: The vast majority of military satellites do not have the ability to detect when they are being attacked.[37] Even more alarming, of the few that can determine when they are being targeted, only a very small percentage are "hardened" with the capability of taking any action to protect themselves.[38] Because these systems are expensive in terms of weight and cost, faced with constrained budgets previous constellation planners have accepted the risk and eliminated detection and protection requirements from satellite programs.

Consequently, U.S. Space systems are vulnerable to a range of attacks including jamming, lasing, and hacking, both from the ground and even more effectively from other satellites in space. Incidentally, these vulnerabilities further highlight the need for a rapid launch capability should our satellites be damaged and require emergency replacement.

Knowledge of these systems and how to use them is increasingly available on the open market. Russia is marketing a handheld GPS jamming system. A one-watt version of that system about the size of a cigarette pack is priced at $400 and is able to deny access to GPS out to 80 kilometers. This system is compact and powerful enough to jam an aircraft's GPS receiver signal, which could disrupt military missions or create havoc at civilian airports.[39] Recent examples of satellite jamming include Indonesia jamming a transponder on a Chinese owned satellite and Iran jamming satellite TV broadcasts of dissidents.[40] A U.S. Defense Science Board study concluded recently that DoD's the three main GPS priorities should be "antijam, antijam, antijam."[41] In addition to long-held U.S. intelligence estimates that Russia possesses laser technology to threaten satellites, the Chinese have now claimed openly they have an operational ground-based anti-satellite laser.[42] In February 1999, hackers hijacked a British Skynet communications satellite and blackmailed the British government refusing to stop interfering with the satellite until a ransom was paid. This was a military satellite with protected and encrypted links.[43]

Commercial Systems: All of the threats to military satellites apply to commercial satellites as well. However, whereas at least some military systems have limited detection and hardening capabilities via regulated requirements, no such requirements exist for commercial satellites. Protection systems greatly increase cost, and with profit the driver for commercial companies, they are virtually nonexistent. This is particularly troubling recalling that 80% of all military communications during Operation Allied Force traveled over commercial satellites due to inadequate military capability, and the significant economic impact of commercial satellites described in the Economic Well-Being section. Worse yet, a 1998 National Defense Industry Association study concluded commercial companies would

not actively pursue protective measures until the first satellite was confirmed destroyed by hostile means.[44]

Budgetary Allocation:

"Space capabilities are not funded at a level commensurate with their relative importance. Nor is there a coherent plan to build up to the investments needed to meet requirements.
Space Commission Report[45]

Underlying the inadequacies in Counterspace and Launch Operations (Space Support) discussed

above is an uncoordinated, unprioritized, and arbitrarily constrained resource allocation process. According to the General Accounting Office, DoD lacks a coherent investment plan that reflects DoD-wide space priorities to guide the development of the Services' budget submissions. Services are pursuing different priorities, with no assurance that the end products are satisfying the needs of warfighting commands or the nation as a whole.[46] Additionally, while the Army and Navy are actually the largest users of space products and capabilities, the Air Force shoulders 85% of total DoD expenditures on space programs.[47] Between 1988 and 2000, Air Force space spending increased by 28% while the Air Force's total share of the DoD budget decreased by 5%.[48] This has created great tension and forced corrosive trade-offs between funding DoD-wide space programs and funding service-specific airpower requirements. Between 1999 and 2007 space's total share of the Air Force budget will increase by 64%,[49] and by 2007 space will account for 65% of the Air Force's total Science and Technology budget.[50] However, even given this significant increase in Air Force spending on space (which of course comes at the expense of its primary mission of maintaining an air force, much to the dismay of airpower purists), this is still nearly $40 billion short of the resources required to address the inadequacies identified above.[51] Chief of Staff of the Air Force Gen Michael Ryan told a defense industry audience, "*constrained by tradition to one-third of the defense budget, the Air Force has hit a brick wall in space.*"[52] Given the arbitrary "1/3, 1/3, 1/3" DoD budget allocation model, which is based on ensuring

harmony rather than maximizing capabilities or requirements, the Air Force cannot continue to maintain a superior air force and close the vulnerability gaps in its space force simultaneously.

Deficiencies and Risks:

Once a detailed evaluation of the capabilities of our programmed forces is complete, both the Bartlett and Lloyd models require a Risk determination. In its broadest terms, Risk is simply the difference between desired ends (national security objectives) and what can be achieved with available means (strategy and forces).[53] As national security objectives flow down to AFSPC mission areas, the Assessment phase clearly shows a "strategic gap" in terms of our ability to support and protect our critical economic infrastructure with our current Launch Operations and Counterspace capabilities. When ends-means mismatches exist, Bartlett points out there are really only two choices; either modify the ends, or change the means.[54] The Hart-Rudmann Commission touched on the Risk in Launch Operations: "*There is no more critical dimension of defense policy than to guarantee U.S. access to outer space, upon which the U.S. military and economy are vitally dependent.*"[55] The Space Commission addressed the Risk in Counterspace: "*The security and well-being of the United States depend on the nation's ability to operate in space. Therefore, it is in the U.S. national interest to develop and deploy the means to deter and defend against hostile acts directed at U.S. space assets.*"[56] This author agrees wholeheartedly with both assessments. Our national interests are clearly articulated and appropriately defined to guarantee national security. The NSS, JV2020, Air Force Posture Statement, and AFSPC SMP have been coherently developed and are mutually supportive; they represent sound guidance for force planning. However, we have not effectively allocated the requisite resources (i.e., properly programmed our space forces) to meet our vital interests. We must therefore adjust our means.

Prescriptive Solutions:

Budgetary recommendations: The underlying foundation of the strategic gaps in both

our Launch Operations and Counterspace capabilities is our uncoordinated and arbitrarily constrained budget process. To rectify this situation, two solutions are offered:

1) Establish a Major Force Program (MFP) for space under the direction of Strategic Command (STRATCOM), the Combatant Command responsible for U.S. space forces. The Special Operations Command model should be employed, whereby STRATCOM is responsible for coordinating and prioritizing all space requirements, and funds are appropriated directly to the MFP and "fenced" from being used by the services to pay for non-space related programs. This will provide a coherent, synergistic strategy in programming our space forces, ensure warfighter (vice Service) priorities are met, and allow the Air Force to focus its budget on maintaining airpower and strategic lift capabilities.

2) Provide space funding based on capability requirements vice a "fair-share" approach. This approach is more in line with Secretary Rumsfeld's Transformation Guidance and would target spending on technologies that underpin all of our transformational capabilities. Precedent exists. From the beginning of the Cold War, the U.S. recognized that strategic nuclear deterrence was a vital national interest far outweighing inter-service rivalries and demanded a larger share of the defense budget. The Air Force, tasked with building a massive strategic bomber and ICBM force saw its share of the DoD budget soar. From 1952 to 1964 the Air Force averaged 44% of the total DoD budget, peaking at an amazing 48% of the total DoD budget in 1960.[57] This solution is required regardless of whether or not recommendation #1 is adopted; whoever is charged with funding space (the Air Force or STRATCOM) they need to be relieved of the burden of an arbitrarily constrained budget share.

Launch Operations recommendations: As demonstrated, the U.S. launch infrastructure and launch capabilities are fragile and vulnerable to attack, non-responsive to warfighter needs,

and are excessively costly. Four solutions are offered to combat these deficiencies:

1) Fully fund/execute AFSPC's launch infrastructure upgrade program. This will reduce launch costs, increase flexibility to military programs, and induce more U.S. commercial companies to utilize U.S. launch services. This will also yield greater cost sharing and further reduce costs.

2) Invest in microsatellite technology. Launch costs are directly proportional to satellite size and weight, therefore the technology to reduce these design factors would allow significant savings. Smaller satellites would also allow inclusion of hardening capabilities with less cost impact, and enable the implementation of the next proposed solution.

3) Develop smaller ELVs with mobile launch platforms. Not only would smaller satellites and smaller rockets significantly reduce cost, but they would also provide surge capacity at the two existing launch bases increasing responsiveness to the warfighter. Mobile platforms would also reduce vulnerability to attacks or natural phenomena, eliminating our single point failures.

4) Aggressively pursue RLV technology. In the long-term, RLVs promise aircraft-like operations in space at a fraction of the cost of ELVs. They are also the answer to a truly responsive, rapid
reconstitution capability necessary to fully exploit the space medium.

Counterspace recommendations: Satellite designs have not kept pace with the rapidly growing threat to on-orbit systems. Whereas moderate risk may have been acceptable in the past given limited threats, today the risks are far too high to be ignored. While improved budgets and more cost-efficient and responsive launch capabilities will both contribute in this area, three additional solutions are key to securing our critical space capabilities:

1) Develop and mandate robust threat detection systems and hardened capabilities for all military satellites. Satellites must be able to detect attack, and then respond to protect themselves. Lens control shutters, antijam capabilities, nuclear hardening, automatic frequency hopping, and improved encryption systems are all technologies that must be targeted for increased investment and development.

2) Develop a threat warning and assessment network. Once attacks are discovered, we must have the ability to provide rapid warning to all U.S. systems and allow coordinated emergency response. Just as an integrated threat response capability is critical to successfully defending against air, land, and sea attacks, so too we must have the ability to provide centralized control of satellite response capabilities.

3) Mandate commercial communications satellites include at least baseline detection and protection systems. If industry will not protect this critical economic infrastructure, the Government must do so.

Alternatives:

Lloyd's Framework includes, as does any well-constructed analytical model, the consideration of Alternatives. This phase necessarily takes place prior to the final force programming decisions. However, I purposely deferred this discussion until now to limit the scope of this paper and tailor it to my specific prescriptive solutions. I have already addressed the alternative view that threats may be exaggerated. Accepting the threat is real requires the ability to protect our satellites, and should they be damaged or destroyed we must have a cost-effective, rapid launch capability to replace them.

Budget: Some may argue DoD set up an MFP-like organization recently. However, it was merely an accounting tool. It did not give the warfighting commander (STRATCOM) control over the budget or prioritization, nor does it fence funds appropriated for space.

Launch Operations: Critics may argue that redesigned ELVs will achieve cost savings and shorter response time. That is true--temporarily. However, RLVs offer "order of magnitude" improvement. Only RLVs and smaller satellites will achieve our vision of "aircraft-like" space operations and provide transformational, leap-ahead capabilities our leadership envisions.

Counterspace: Many spacepower advocates argue the best way to protect our satellites from space-based threats is to develop on-board weapons to destroy hostile satellites. I disagree. Weaponization of space is an intensely controversial subject, in the U.S. and

internationally. Our choice to weaponize would have two significantly negative effects. First, it requires obviation of multiple international treaties and unilateral U.S. action. This would not be wise in the current post-Iraq environment. Second, it would signal to the rest of the world the space weapons race is on. Encouraging other nations to weaponize space would not be in our best national interests. Critics may also complain about mandating commercial satellite protection requirements. However, this is no different than the Federal Aviation Administration regulating commercial aircraft requirements, and the Interstate Commerce Commission regulating commercial trucking, to provide safety and security in our airways and on our highways. So too the critical commercial infrastructure in space must be protected.

Conclusions:

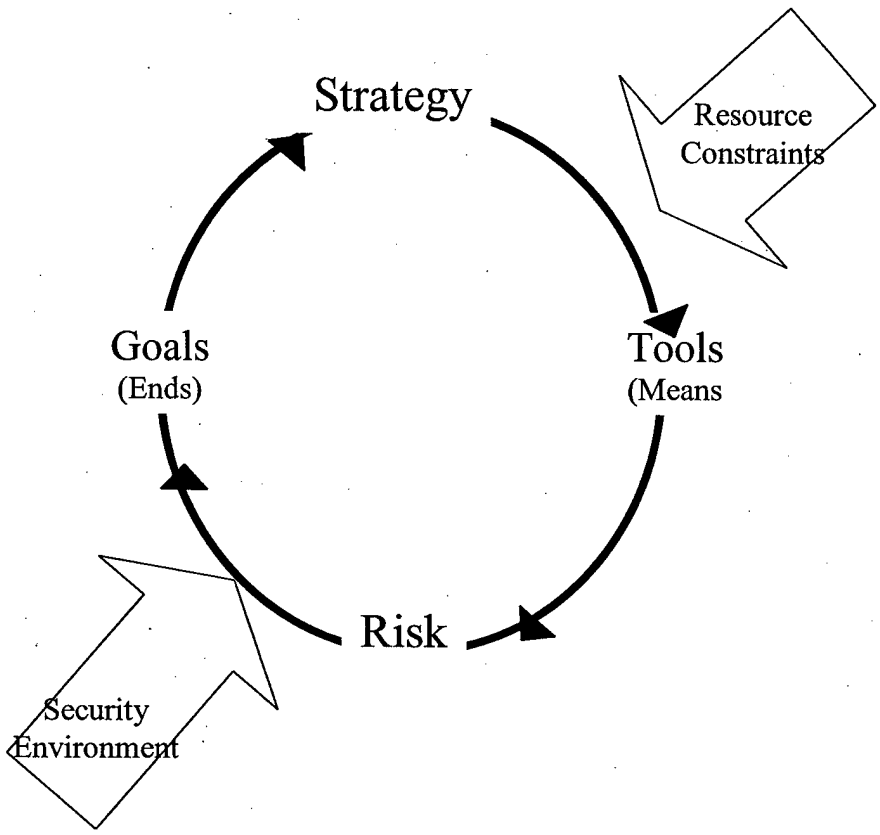
"History is replete with instances in which warning signs were ignored until an external "improbable" event forced resistant bureaucracies to take action. The question is whether the U.S. will be wise enough to act responsibly and soon enough to reduce U.S. space vulnerability. Or, whether a Space Pearl Harbor will be the only event able to galvanize the nation and cause the U.S. government to act."

Space Commission[58]

Using analytical models for analyzing strategy and force planning, it has been demonstrated that U.S. space capabilities are absolutely critical to ensuring our vital national interests, including supporting and protecting our economic well-being. In fact, the use of space has become so important to U.S. security and the American way of life that President Clinton, Secretary Rumsfeld, and Chairman Myers consider space a vital national interest in its own right. But our growing dependence on space and its increased strategic importance also increases its attractiveness as a target. Whether in terms of classical Clausewitzian, post Cold-War asymmetric warfare, or the emerging post-9/11 Chaos theories our space systems are lucrative targets. Unfortunately, they are also extremely vulnerable targets, especially in the critical mission areas of Launch Operations and Counterspace upon which the sum total of our space power is dependent. Attacks against these critical nodes could be devastating to our ability to defend our homeland and create chaos in domestic economic systems. The risk

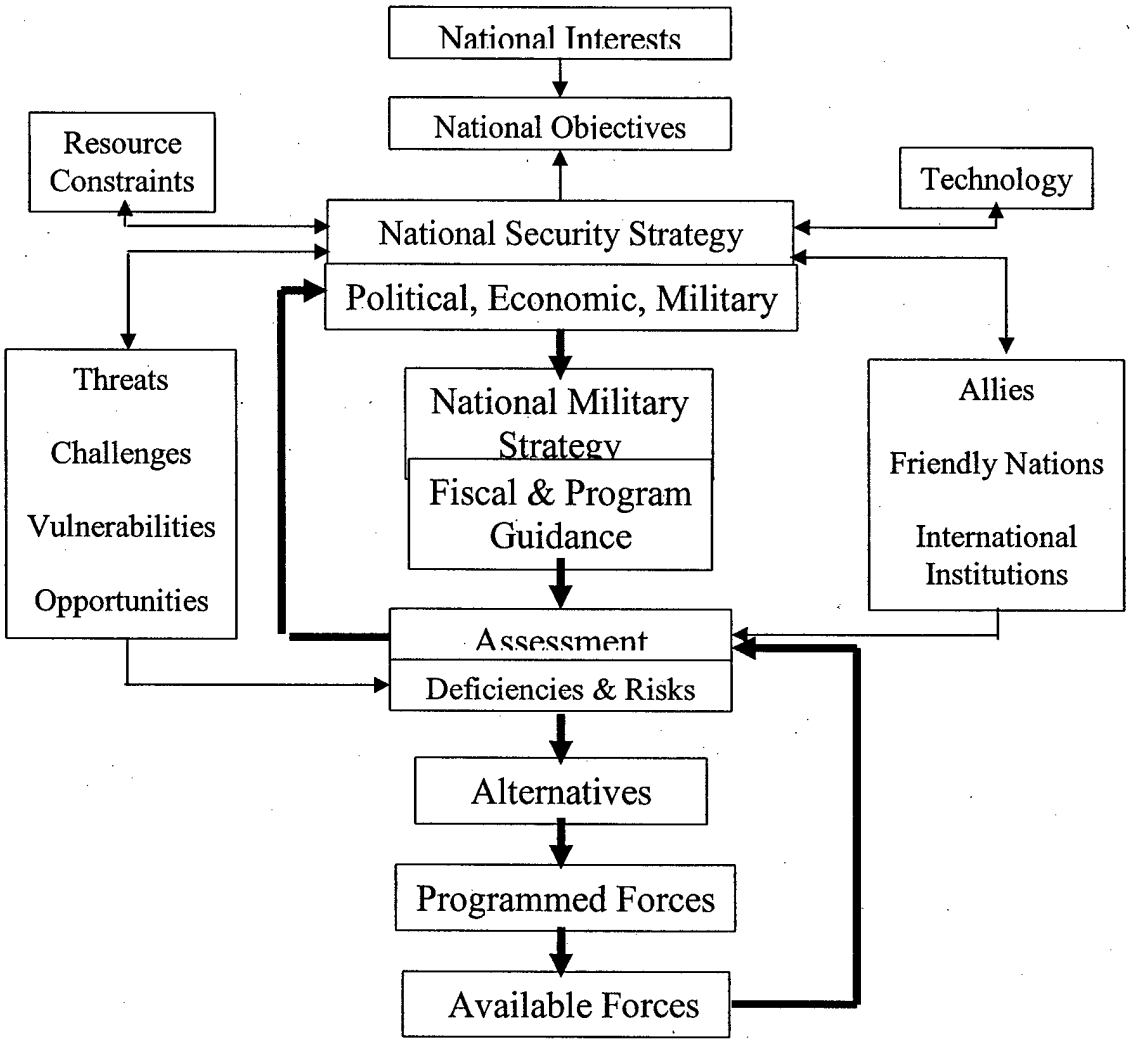
resulting from our ends-means mismatch is too high to ignore. Through increased funding, and development and mandate of new technologies, we must provide our space programs the proper resources commensurate with the vital national interests they have been charged with securing.

Appendix A



Bartlett Doughnut

Appendix B



Lloyd Framework

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