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SPACELIFT – THE ACHILLES’ HEEL OF AMERICAN SPACE POWER

by

Robert W. Stanley II
Major, U.S. Air Force

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

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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“History is replete with instances in which warning signs were ignored and change resisted 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, as in the past, a disabling attack against the country and its people—a “Space Pearl Harbor”—will be the only event able to galvanize the nation and cause the U.S. Government to act.

We are on notice, but we have not noticed.”¹

- Rumsfeld Space Commission Report

Abstract

SPACELIFT – THE ACHILLES’ HEEL OF AMERICAN SPACEPOWER

During Desert Storm, U.S. forces relied heavily on space-based capabilities to defeat an enemy. America has since grown even more dependent on these assets. Warfighting Commanders-in-Chief (CINCs) now routinely plan exercises and employ forces under the assumption that they will have unimpeded access to Global Positioning System (GPS) and communications satellites as well as meteorological and Intelligence, Surveillance and Reconnaissance (ISR) platforms. But if one or more of these fragile capabilities are diminished as the result of enemy action, or simply because of natural phenomenon such as solar flares, how quickly can we replace the neutralized satellites? The answer is not comforting, and revolves around the limited capability of the U.S. spacelift program.

Attention has been especially focused on our spacelift program during periods following major failures. In addition to the loss of life, launch failures have cost our nation billions of dollars, significantly reduced our access to space for lengthy periods, and resulted in delayed deployment of next-generation ISR assets. While many measures taken after these disasters were effective in getting America back in space, much work remains. Our launch programs must become more responsive to the warfighting CINC.

It simply takes too long to get a working satellite on orbit and ready for operations. Secondly, the government needs to work more efficiently with U.S. industry. National security depends on the ability of American launch service providers to compete favorably with several thriving foreign counterparts. Finally, our launch programs must be made more robust and less reliant on single-points of failure.

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Thesis

America's reliance on space-based assets continues to grow dramatically following the surprisingly successful integration of these capabilities with our conventional military during the Gulf War of 1990-91. Our regional CINCs now count on space-based platforms to enable such capabilities as navigation, communications, meteorological support and ISR. Unfortunately, these capabilities are vulnerable not just to enemy attack, but also to natural phenomena and simple mechanical or software failure.² These vulnerabilities mean the ability to quickly replace a neutralized satellite may decide the next conflict.

Our nation's capacity to replace damaged satellites and ensure fully operational constellations is dependent on our fragile spacelift program. To provide the type of support the warfighting CINCs must have, three major areas of this program must be enhanced. First, current spacelift is unresponsive. Months, and even years may pass before a space asset is in place after a CINC identifies the need for support. Secondly, the U.S. government needs to ensure domestic spacelift contractors are allowed to operate efficiently on government-owned launch ranges. Competition from dynamic foreign launch agencies continues to weaken the domestic industry upon which our warfighting CINCs depend. National security and the health of this critical industry are inextricably linked. Finally, America's launch infrastructure, its key components as well as many of its functions are too fragile, and lack redundancy. Astonishingly, warfighting CINCs are largely unaware of the tenuous nature of the space support they now take for granted.

Overview

In 1986, the dramatic and heartbreaking loss of life that resulted from the Space Shuttle Challenger disaster masked an even more disturbing problem. America had placed all of its

eggs in one basket, and that basket was now gone. The Space Transportation System (STS), as the shuttle is formally known, was to form the backbone of the U.S. defense satellite launch program. The concept seemed sound and leveraged billions of dollars in research spent by the National Aeronautics and Space Administration (NASA) and the Department of Defense (DoD) to develop a reusable launch vehicle. With the STS, America would be able to place a wide assortment of spacecraft of varying sizes and capabilities on orbit quickly, reliably and without the waste associated with our expendable launch vehicle (ELV) program. This responsive capability was exactly what the military's warfighting CINCs and NASA would need. However, because of budget constraints, no backup plan was developed. The Challenger disaster underlined this flaw in logic.

A crash program was instituted to ensure military satellites could be put into orbit during the period while the shuttle fleet was to be grounded. America turned to ELVs, and names like Delta, Atlas and Titan became household words once again. Unfortunately, because the new ELV program was put together with such haste, many shortcuts were taken and potential problems that could surface down the road were overlooked. Some of the potential problems included: poor responsiveness to warfighter needs, inefficient organizational structures leading to mystifying chains of command, and lack of redundancy in launch facility infrastructures and key sub-component industries. When coupled with an exorbitant cost-per-pound to get spacecraft into orbit, a critical vulnerability began to emerge.³ These and many more deficiencies had to be set aside for the sake of doing something immediately.

The relatively unforeseen dependence of our military on space-based assets, dramatically smaller budgets, a different type of enemy, and leaps in technology now act in concert as a double-edged sword that on the one hand presents us with what appear to be insurmountable

obstacles, but on the other, gives promise for resolution. Let us address a few of these obstacles, and offer possible solutions to help stave off disaster for America on the battlefields of the near future. It is crucial to ensure the operational CINC has the unique space-based assets he needs quickly and efficiently.

How Responsive is Spacelift?

For today's warfighter, the presence of a GPS signal is as routine as expecting the lights to come on in your kitchen when you flip on the wall switch. As stated by a former Commander in Chief, U.S. Space Command, (USCINCSpace), "As a measure of merit, GPS is so well integrated into air, land, and sea operations that it is in many ways taken for granted. Like the telephone dial tone, everyone just expects it to be there."⁴ If a regional CINC's forces were engaged in combat, even a few weeks without space support could be devastating. Following a U.S. Army war game in which friendly satellites were disabled by a nuclear weapon detonation in low earth orbit, one participant commented, "They took out most of our space-based capabilities. Our military forces just ground to a halt."⁵

Unified CINCs are becoming aware of the grave consequences. Thus, planning for a concept known as Navigational Warfare (NAVWAR) is now a priority.⁶ This program seeks to ensure the enemy cannot deny our forces the use of GPS, or use it for their own purposes. More advanced potential enemies have acquired the ability to jam or disable the relatively weak downlink signal from GPS satellites. This is also significant to the concept of Network Centric Warfare (NCW). If GPS navigational signals are jammed, the corollary timing signals used to allow secure, semiautonomous communications in the field are also blocked. Friendly forces would lose the capability for secure, real-time communications, thus losing the ability to self-synchronize. Without self-synchronization, NCW's foundation crumbles.

But what recourse does a CINC have if the enemy develops or acquires the capability to disable a satellite on orbit? Under routine circumstances, Air Force Space Command (AFSPC) provides for replacement of satellites via a series of status and scheduling meetings throughout the year involving all key agencies with a stake in upcoming spacelift missions. This group is called the Constellation Sustainment Review Board, or CLSRB. These stakeholders usually include at a minimum: the prime launch vehicle contractors, primary spacecraft contractors, various AFSPC communities, the Space and Missile Center (SMC), NASA, Air Staff, the National Reconnaissance Office (NRO), USSPACECOM, the National Oceanographic and Atmospheric Administration (NOAA), the Aerospace Corporation, and the Department of Transportation (DoT). Depending on the type of upcoming missions, even more stakeholders may be present. However, this list serves to highlight the minimum number of agencies with a vote for when missions will be launched. Conspicuously absent is the supported CINC who is dependent on USSPACECOM to represent his needs. In any event, there are a lot of cooks in the kitchen.

From the time this group concurs on the need to launch a satellite until it is ready for use can range anywhere from three months to as long as three years depending on the type of spacecraft to be launched, necessary booster and launch pad, range availability, and required launch window. This is clearly unacceptable to the warfighter. While every attempt is made to ensure potential on-orbit satellite failures are accurately forecasted and considered in budget planning and schedules, plans are still ready to provide for unexpected failures.

Called “Launch to Sustain – Unplanned”, or (LTS-U), USCINCSpace’s contingency launch plan is in place for the possibility of a failure resulting from enemy action, mechanical or software failure, as well as any other unforeseen circumstance that degrades or neutralizes

a constellation.⁷ This strategy first calls on USCINCSpace to solicit Operational Considerations (OC) from Navy Space Command (NAVSPACE), Army Space Command (ARSPACE), or 14th Air Force (SPACEAF) as required.

These OCs are then forwarded to COMSPACEAF, who will coordinate them with all major stakeholders represented on the CLSRB. This review allows COMSPACEAF to highlight potential schedule conflicts within each OC, as well as any need to preempt a planned launch. COMSPACEAF then forwards a recommended OC and detailed explanation to USCINCSpace for further coordination and final approval. (See Appendix B for a graphic depiction of the process.)

It is generally preferable that the OC selected not require an unplanned launch, but rather a work-around to provide the warfighter with the capability needed until the satellite can be replaced via the normal process. As a matter of course, all possible methods for providing the necessary capability will be examined by USCINCSpace before going the route of preempting a scheduled launch. Preemption of a previously scheduled launch often involves heads of state since many of the telecommunications satellites scheduled for launch from U.S. ranges are owned and operated by foreign agencies with millions of dollars at stake.

Even a relatively minor slip of a few weeks can devastate a company trying to obtain commercial satellite coverage ahead of a competitor. Preemption of such a mission will almost certainly damage our domestic space launch industry due to the tight competition they face from several very efficient foreign launch service providers such as Ariane, or the Russian and Chinese Space Agencies. Needless to say, political pressure to stay on schedule is immense, and USCINCSpace had better be sure it is absolutely necessary if he decides to go the route of preemption to launch a DoD satellite. However, in the event of a national

emergency, mechanisms are in place to ensure the warfighters' needs are placed far above all other considerations.

But even if a commercial mission is preempted in favor of a DoD mission to support the unified CINC, will it be enough? Let us look at a possible scenario and the steps that must be taken if our National Command Authority (NCA) decided to support preemption of a commercial launch. Put yourself in the shoes of a warfighting CINC as this process unfolds.

For example, let us assume America and her allies are engaged in a major conflict with North Korea. With Chinese assistance, the North Koreans have disabled a number of our GPS satellites, creating a "hole" in navigational coverage over a large portion of the region. At least one new GPS satellite must be placed in a particular orbit as soon as possible to bring the constellation back to minimal operating capability. USCINCSpace decides to order preemption of a commercial Delta II launch scheduled with a telecommunications satellite for Brazil. We will assume that a GPS spacecraft is in storage at Cape Canaveral and will begin processing for launch as soon as the "call-up" is received. We will also assume that the needed booster components for the GPS launch are readily available.

To support LTS-U, America's two prime launch vehicle providers, Boeing and Lockheed Martin, are on contract to support an emergency launch call-up in 40 and 60 days, respectively. Since the Delta II is a Boeing booster, we will use 40 days as the total time necessary from call-up for the booster to be ready for launch. However, in schedule compression exercises conducted by both companies, their boosters can be launch-ready in as little as 19 days.⁸ If we assume Boeing succeeds in readying the booster for launch in 19 days, we may just succeed in getting the GPS on orbit as much as three weeks sooner than the normal LTS-U flow would have allowed, right? There is a catch.

The component that usually requires the most time in the launch schedule is the spacecraft. For instance, our relatively simple GPS spacecraft requires a minimum of six weeks to be ready for launch no matter what contingency is ongoing. So, even if we "bump" the Brazilian telecommunications mission and execute the 19-day booster flow, we are still left waiting the full 42 days for the GPS satellite. Had we not bumped the Brazilian mission, we would have had to allow it approximately 30 days for processing and launch, then tacked on our GPS mission's 19-day accelerated booster flow. During that time, the satellite would have been processing as well, so the launch could have feasibly happened within 49 days from call-up. In the end, by bumping the Brazilians, we only gained one week. Bottom line, even with an LTS-U execution, the spacecraft drives the schedule, and may mean the U.S. Government pays to maintain a multi-million dollar LTS-U capability that in all likelihood will never be used. Further, having this unplanned launch strategy on the shelf may also serve to give our warfighting CINCs a false sense of security.

Once launched, the new GPS satellite would require on average, between four to five weeks of on-orbit checkout and preparation before being declared "operational." This checkout process would obviously be accelerated as much as possible, but would still take as much as two to three weeks to get the spacecraft up and running. As you can see, *if* everything went perfectly, the total amount of time for a relatively simple GPS satellite to be declared ready would, at a minimum, take nearly three months from the time of the request.

For our scenario, we made several fairly broad assumptions. We presumed Brazil would not formally seek legal action or intervention by the U.S. Departments of State, Transportation or Commerce against Boeing or the DoD for preempting its mission. Further, we assumed that no higher priority launches were scheduled ahead of our GPS mission by

any of the various members of the CLSRB. Add to the equation the common uncertainty of severe weather at the launch site and routine variables such as hardware damage during shipping, and three months begins to look very optimistic indeed.

Moreover, a sophisticated DoD communications or reconnaissance satellite, coupled with an infinitely more complex and troublesome booster, like the Titan IV, would require several more months than our relatively simple GPS/Delta II combination. In the end, CINCs would probably not consider a *minimum* three-month wait to receive a GPS signal as “responsive.”

During the three-month wait for navigational signals to resume, the North Koreans (and possibly the Chinese), would attempt to take advantage of the situation as best as they could. Unless our forces were trained, ready and able to fall back on old methods of navigation, they would be in dire straits. Non-secure communications might also be severely degraded during this time. It is naïve at best to think our potential adversaries have not already planned for such a strike at this critical vulnerability. A theatre CINC’s C², meteorological and ISR assets are also at risk, putting in jeopardy his entire decision-making process.

The Hurricane That Will Eventually Come

On 14 September 1999, the United States came face-to-face with a disaster of awesome proportions. Hurricane Floyd, a monster storm more than three times the size of Hurricane Andrew and packing winds between 140-155 mph (gusts up to 190 mph), was bearing down on Cape Canaveral. To fully comprehend the implications of a storm this size striking Florida’s “Space Coast”, it is appropriate at this point to briefly describe the significant roles played by each of our nation’s two primary spaceports, Cape Canaveral Air Force Station (AFS)/Kennedy Space Center (KSC), and Vandenberg AFB.

Starting with the West Coast, Vandenberg AFB is situated along California's Central Coast, approximately equidistant between Los Angeles and San Francisco.⁹ Vandenberg AFB's importance to our space program is underscored by the fact that it is the only U.S. installation from which unmanned government and commercial satellites can be launched into a polar orbit (see appendix for definition). Additionally, it is the only U.S. installation from which spacecraft can be placed into a retrograde orbit (see appendix for definition). In terms of actual spacecraft, this means Vandenberg AFB is the site from which meteorological and certain types of reconnaissance satellite missions must be launched. The primary threat to Vandenberg AFB is its proximity to several fault lines running through the region.

On the East Coast, Cape Canaveral is located midway up the Atlantic Coast of Florida, and serves as the only spaceport in the U.S. from which satellites can be launched into prograde orbits efficiently (see appendix for definition). What this means in terms of hardware: GPS, a variety of DoD communications satellites as well as many types of reconnaissance and early warning platforms are launched from "the Cape." It is important to note that the two launch sites described are not interchangeable for most DoD missions.

Simply put, the neutralization of either Cape Canaveral or Vandenberg AFB would have a crippling impact on the warfighting CINC over time. If the Cape were shut down indefinitely, systems such as GPS, Defense Satellite Communications System (DSCS), Defense Support Program (DSP), and Milstar could not be sustained or replenished. If Vandenberg AFB was incapacitated, meteorological, and national ISR assets could not be supported. In short, losing either of these installations would ravage the systems U.S. CINCs have trained with and depended on since Desert Storm.

With Hurricane Floyd on a direct path toward Cape Canaveral, NASA and the Air Force prepared for the worst. It was understood that even if the numerous launch pads and support buildings which dot both Cape Canaveral AFS and KSC survived the devastatingly high winds, the hardware in storage and C4 infrastructure would not survive the storm surge.¹⁰ The launch infrastructure upon which America's space program primarily depends is designed to survive maximum winds of between 105-125 mph, but nothing has been done to compensate for the storm surge aside from sand bags and prayers.

Cape Canaveral sits precariously at a mere nine feet above sea level. Additionally, most of the launch pads, as well as hardware storage facilities are less than a few thousand feet from the beach. Hurricane Floyd's storm surge was expected to reach sixteen feet, and flood inland as far as Titusville, (approximately fifteen miles northwest of Cape Canaveral.) This meant that all of Cape Canaveral and Kennedy Space Center would potentially be under several feet of water for many days. The impact of floodwaters on delicate boosters, spacecraft and space shuttles in storage would be absolutely catastrophic, and could have resulted in direct losses of over \$12.5 billion.¹¹ No estimates were prepared in determining the length of time necessary to affect repairs and get back on schedule. Suffice to say, it would be measured in years, perhaps even decades. The impact on space support to the warfighting CINC could have been disastrous. Fortunately, Hurricane Floyd turned north just a single day before its predicted landfall, and missed the Cape by a scant 100 miles.

The precarious locations of our two spaceports are not the only single-points of potential failure USSPACECOM must consider. For example, Arch Chemicals, Inc., is the sole American supplier of two critical fuels known as hydrazine and its derivative, Aerozine-50. Nearly every type of booster and spacecraft in the U.S. arsenal uses these two fuels. The

plant where Arch Chemicals produces these fuels is located in Lake Charles, Louisiana. This is also where the chemical is stored until ready for shipment to our launch bases. While a serious fire, or other incapacitating mishap could certainly spell disaster for our launch program, the point to highlight here is economic in nature, and has just as great an impact on space support to the warfighting CINC.

Last year, Arch Chemicals' proposed an annual increase of nearly 182% for the cost of hydrazine and its derivatives, sending shockwaves throughout the Air Force's budget process.¹² Based on the vast quantities of these fuels used by the Titan IV program alone, it became necessary to consider canceling several launches or postponing them indefinitely. Several of the missions considered for postponement were considered "critical" by USSPACECOM. They included Milstar communications and DSP early warning satellites.

Alternatives to using Arch Chemicals were explored and eventually dismissed. The U.S. government decided it was not in our country's best interest to depend on the only other company in the world who could supply us with the quantity of hydrazine needed. The reason? That company is based in France. In the end, the budget was adjusted, and Arch Chemicals got a large portion of the increase they demanded.¹³ This incident underscored the need for competition to help drive prices down, and provide multiple sources of vital commodities. It also highlighted the potential dilemma if Arch Chemicals ceases to exist, or forces our space program to become dependent on a foreign company for critical fuel.

The effect of losing this single-source supplier would have a similar impact on space-based assets as described earlier in the discussion on our two launch bases. However, the Arch Chemicals example serves to highlight the threat to the defense budget posed by lack of domestic competition. In one fell swoop; Arch Chemicals could (and did) demand such an

enormous increase in fuel prices that other defense programs suffered. The impact could be felt across the board, and not just confined to the Air Force. It would be tragic to have to cancel a program truly needed by a warfighting CINC because our budget was at the mercy of a sole supplier. From this perspective, it is vital that U.S. leaders understand the term “hurricane” must be considered both literally and figuratively, and it *will* eventually come.

What We Can Do – Streamline

As America charts a course that will take our nation even further down the path of dependency on space-based capabilities, there are several potential solutions to our frail spacelift program. The first issue that must be addressed is that of efficiency. Like every other enterprise, the American spacelift industry is just that, an industry. The companies involved rise and fall on their ability to make money and stay competitive.

Peculiar to spacelift is the fact that the U.S. Government is the owner and operator of all of the nation’s space launch ranges. Moreover, until the Evolved Expendable Launch Vehicle (EELV) comes on line, the government will also be the owner of all launch complexes situated on both ranges. This means that for every launch, regardless of the type of payload, there is an enormous cast of characters from the U.S. Government that launch contractors must deal with. Thus, even for commercial launches, the government is responsible for ensuring safety of all personnel on the launch complexes, and that these national assets are not damaged as a result of negligence.

In most cases, the relationship is healthy and leads to process improvement. However, there are many instances where the contractor is faced with the dilemma of finding out exactly who is in charge so a key decision can be made. Multiple government masters often

act to reduce our domestic contractors' efficiency, and along with the constant threat of being preempted, can result in customers taking their business to a foreign launch service provider.

In May 2000, HQ AFSPC inspectors observed a real-world GPS launch during an Operational Readiness Inspection. The President's Broad Area Review (BAR) of the country's spacelift program had just published recommendations regarding organizational structure that were being implemented. These organizational recommendations were vague enough that the result was two Air Force organizations (SMC and AFSPC), claiming equal responsibility for launch. For the mission under IG observation, the result was confusion. The launch was actually scrubbed during the first attempt in part due to miscommunication between SMC and AFSPC. The agency that bore the brunt of the confusing chains of command was Boeing. Their team of engineers had correctly determined that a minor glitch observed in the command and control software earlier in the countdown was satisfactorily resolved, and the mission was now ready for launch. Unfortunately, SMC and AFSPC personnel were formed into separate teams to resolve the anomaly *independently of each other and Boeing*. By the time both agencies had come to resolution, the launch had to be cancelled for the day.¹⁴

This singular example of inefficiency is endemic to American spacelift in general, and illustrates one reason why our domestic launch programs have much higher costs than those of key competitors. It is not hard to imagine why even domestic commercial agencies who want to put a satellite on orbit would choose to go to Ariane, Russia or China, where the reliability is lower, but the cost of overhead is dramatically less.

EELV is meant to go a long way toward resolving this problem.¹⁵ In the past, the U.S. Government has purchased specific boosters to put spacecraft on orbit. With EELV, the

government purchases a launch service. The concept of purchasing a service instead of hardware, allows the government to focus its involvement with the contractor on observation of overarching processes instead of direction for every critical task. While it is vitally important that the government maintain “eyes on” the contractor, the involvement can be significantly reduced, and focused toward management and quality control. Properly implemented, this concept means the contractor will be allowed to do business as they deem most efficient so long as they are able to meet safety standards and get DoD payloads safely on orbit when and where we require them. If this efficiency is applied to both the booster and spacecraft, the result will be a direct benefit to the warfighting CINC who should see a significant reduction in processing and integration time before launch measured in months.

In addition to the concept of purchasing a launch service, both Boeing and Lockheed Martin leased government land at Cape Canaveral and Vandenberg AFB to build complexes for each company’s variant of these next generation modular boosters.¹⁶ This is significant because the government will no longer own the launch pads, and thus, the contractors should ostensibly be allowed greater leeway in how they conduct business on “their” complexes. The resulting organizational structure should reflect a much cleaner chain of command.

As this new concept is developed, government interests will continue to dictate that involved military observers be present in order to ensure the pads, on which military missions will be dependent, are properly cared for and maintained. In past experience with an excess capacity “leased” launch pad, a contractor chose not to conduct routine corrosion control resulting in a mobile service tower (MST) on which certain floors were unsafe. Based on this experience, it is vitally important that the government not back away entirely. The launch service concept is but one opportunity that may allow the government to

streamline its relationship with our two primary launch contractors. The other opportunity comes in the form of the Commission to Assess United States National Security Space Management and Organization, or the Rumsfeld Space Commission.

Mandated in response to Congressional charges that the Air Force was a poor steward of space, the Rumsfeld Space Commission sought to identify ways to ensure proper government space advocacy. The commission's primary recommendations revolved around streamlining the agencies within DoD most responsible for space. In addition, the commission recommended the Air Force receive formal Title 10 authority for space. In response, the government instituted several changes that could lead to a more efficient spacelift program.

Chief among these changes was the realignment of the space acquisition community under AFSPC to more directly reflect the organizational structures within the National Reconnaissance Office (NRO).¹⁷ The NRO is widely acknowledged to have the most efficient chain of command for effective space operations. Specifically, the NRO structure is effective for both working with spacelift contractors and ensuring government needs are met.

Until this change was made, all acquisition activities for space were under Air Force Materiel Command (AFMC), and led to a great deal of miscommunication between the acquiring command (AFMC) and the operating command (AFSPC.) The poor internal government communication cited during the GPS mission was just one small example of the inefficiencies created by this construct. With the acquirers, operators and maintainers all working for the same four-star, there is a real opportunity to alleviate the problem of multi-headed government interfaces for contractors. Additionally, the personnel cross flow between operations and acquisition should improve understanding of the spacelift mission.

What We Can Do – Eliminate Reliance on Single Points of Failure

As pointed out earlier, the U.S. and its warfighting CINCs are dependent on space as never before in its history for military dominance. As this dependency increases, the importance of increasing our capacity for spacelift as well as the importance of getting our eggs out of just a few baskets is absolutely vital. But how do we do it in the next 10 to 15 years, before concepts such as the National Space Plane come into being? In addition to possibly launching more spare satellites into orbit, I believe the answers lie in encouraging competition among suppliers of critical commodities, as well as smaller, simpler, and more flexible launch systems such as Pegasus, Taurus and Sea Launch.

The three launch systems mentioned are extremely small compared to the traditional notion of boosters such as Atlas or Titan. However, these rockets can be launched from mobile platforms such as modified commercial jetliners, and offshore oil rigs. Moreover, since these platforms are so mobile, they can be quickly relocated to take advantage of different locations for more efficient launch performance, as well as to protect themselves from dangers such as enemy attack, severe weather, and so on. From the safety perspective, launch of these platforms can take place hundreds of miles from populated areas, so the huge safety infrastructure necessary for a mission from Florida or California becomes unnecessary.

No longer would our nation and its theatre CINCs be dependent on two stationary locations from which all of our critical national satellites have to be launched. Finally, and most importantly, the capability described above already exists, and has been successfully demonstrated on numerous occasions.¹⁸ The drawback? A stubborn reluctance by the spacecraft design community to develop small, inexpensive satellites that are within the

capacity of these more survivable and less expensive boosters. Lack of commercial demand for these so-called “microsatellites” is the primary reason given for the lack of extensive effort. Advances in technology have permitted reductions in the size of the most powerful computers to a single laptop the size of a briefcase. This same technology is available for use in satellites, and yet paradoxically, spacecraft keep increasing in size. With the cost per pound to get a spacecraft on orbit at approximately \$10,000, it would seem that American industry and government would be eager to produce microsatellites as opposed to school bus-sized satellites such as Milstar.¹⁹ In addition to being cheaper to get on orbit, and thus to replace, they would also present potential enemies with very difficult targets. However, as with other technologically advanced space applications, commercial industry will often let the government play “guinea pig” until the application has proven itself. This means the government will have to jumpstart microsatellite technology by leading the way.

Conclusion

Right now, we have an opportunity. America is the only country capable of using space assets to multiply the power of our conventional forces on so large a scale. This capability makes us both strong and vulnerable at the same time. Eventually, adversaries will gain the ability to strike directly at this new center of gravity whether we are ready for them or not. We must be able to replace space-based assets quickly and reliably for our warfighting CINCs. The critical vulnerability has been identified, the necessary technology and know-how is at hand, and the time is now. All that is missing is the sense of urgency necessary to put armor plating over the Achilles’ Heel of American space power.

Recommendations

Most importantly, warfighting CINCs must be made to understand their options if critical space support is neutralized. With that, it is vital they take into account the extreme length of time necessary to replace on-orbit assets. Further, in spite of the existence of contingency launch procedures, CINCs must know that the end product of these procedures is still not responsive to their needs. Armed with this knowledge, warfighters can build back-up plans to compensate for diminished space support capabilities.

To make our spacelift program immediately more responsive to the warfighting CINC, we must streamline our organizational structures. By clarifying who on the government side "is in charge", we can improve communications with launch service contractors and develop more effective decision-making processes. Further, we should unleash the efficiency inherent in commercial industry by moving ahead with the EELV strategy of purchasing launch services instead of rockets. Coupled with clear, overarching government objectives and incentives, we can encourage domestic contractors to operate as efficiently as possible. While we must remain fully engaged with our launch contractors, we cannot continue to micro-manage every procedure, and critique every turn of the wrench.

For long-term security, individual components of our launch program must be made more robust and redundant. This means we must develop and employ microsattellites that can be launched on existing boosters such as Pegasus, Taurus and Sea Launch. These smaller, less costly boosters will in turn, allow greater flexibility, decrease our dependency on just two spaceports, and reduce safety and scheduling overhead. Finally, our dependence on single-source suppliers must be eliminated by spurring commercial competition in production of vital commodities such as hydrazine and its derivatives.

APPENDIX A - DEFINITIONS

Atlas II. Atlas II evolved from the successful Atlas ICBM program. It is designed to launch payloads into low earth orbit, geosynchronous transfer orbit or geosynchronous orbit.

Defense Satellite Communications System. Air Force Space Command operates ten DSCS satellites orbiting at an altitude of more than 23,000 miles. Each satellite provides secure voice and high rate data communications.

Defense Support Program. Defense Support Program (DSP) satellites are part of North America's early warning systems. In their 22,300-mile geosynchronous orbits, DSP satellites help protect the United States and its allies by detecting missile launches, space launches and nuclear detonations.

Delta II. The Delta II is an expendable launch, medium-lift vehicle that is primarily used to launch Navstar Global Positioning System (GPS) satellites into orbit, providing navigational data to military users.

Evolved Expendable Launch Vehicle. The Evolved Expendable Launch Vehicle (EELV) is the Air Force spacelift modernization program. EELV is intended to reduce the cost of launching by at least 25 percent over current launch systems, and improve standardization.

Global Positioning System. The Navstar Global Positioning System (GPS) is a constellation of satellites providing global navigation data to military and civilian users.

Milstar. Milstar is a joint service satellite communications system that provides secure, jam resistant, worldwide communications for military users.

Polar Orbit. An orbit for which the angle of inclination is 90 degrees. A satellite in polar orbit will pass over both the north and south geographic poles once per orbit.

Prograde Orbit. The orbital movement of a satellite in the same direction as the earth's rotation.

Retrograde Orbit. The orbital movement of a satellite in the opposite direction as the earth's rotation.

Titan II. Titan II is a medium-lift space launch vehicle used to carry the USAF Defense Meteorological Satellite Program (DMSP) and various NOAA weather satellites. The Titan II is only launched from Vandenberg AFB, Calif.

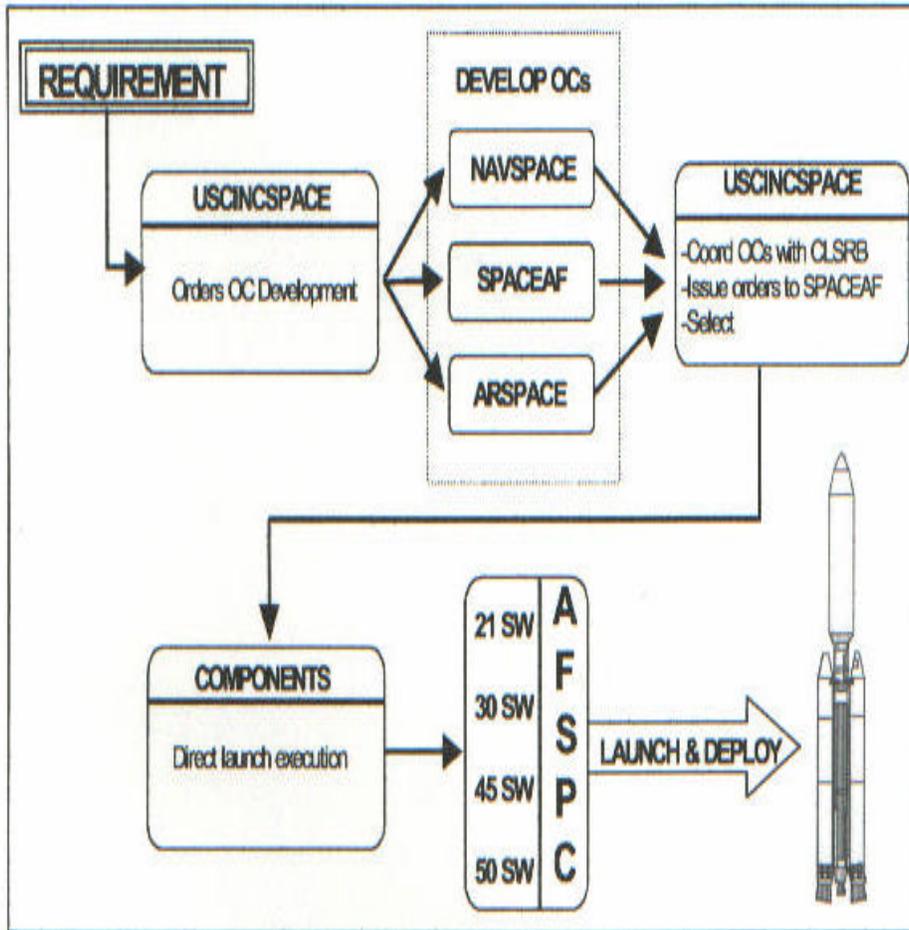
Titan IV. The Titan IVB is a heavy-lift space launch vehicle used to carry government payloads such as DSP, Milstar and NRO satellites into space.

APPENDIX B - CONTINGENCY LAUNCH PROCEDURES

Attachment 5

CONTINGENCY LAUNCH PROCEDURES

Figure A5.1. Contingency Procedures.



NOTES

- ¹ Department of Defense, Report of the Commission to Assess United States National Security Space Management and Organization, (Washington, DC: 11 Jan 01), 15.
- ² Robert S. Dudley, “The New Space Plan”, Air Force Magazine, Jul 98, 1.
- ³ Theresa Foley, “Space: 20 Years Out”, Air Force Magazine, Feb 00, 1.
- ⁴ General Howell Estes, “What’s in a Name”, An Address to International Air Power Symposium, 24 Apr 97, <<http://www.spacecom.af.mil/hqafspc/library/speeches/24apr97.htm>> [3 Jan 02].
- ⁵ Benjamin S. Lambeth, The Transformation of American Air Power, (New York, NY: Cornell University Press, 2000), 246-247.
- ⁶ Minister of Public Works and Gov’t Services, Canada, “NAVWAR Development”, Canadian Forces Avionics Acquisition Plan: NAVWAR, 1999, <http://www.airforce.forces.ca/cfaap/eng/navwar/navwar_e.htm> [18 Jan 02], 1.
- ⁷ Air Force Space Command, Instruction 10-1213 - Spacelift Launch Strategy and Scheduling Procedures, 2 Oct 00, 8.
- ⁸ Dowhan, Mark E. <mark.e.dowhan@Boeing.com> “RE: We’re Here” [E-mail to Robert Stanley fourboilers@earthlink.net] 22 January 2002.
- ⁹ 30th Space Wing, Vandenberg AFB History, (Vandenberg AFB, CA: 30th Space Wing Public Affairs Office, 1998), I.
- ¹⁰ Marcia Dunn, “Space Center Workers Feared Water More Than Wind”, CNEWS – Canada’s Internet Network, 15 Oct 99, <http://www.canoe.ca/CNEWSspace9910/15_floyd.html> [4 Jan 02], 1.
- ¹¹ Joseph Tedino, “NASA Just Says No to Insurance”, Space.com, 4 October 99, <http://www.space.com/news/insurance_991001.html> [5 Jan 02], 1.
- ¹² Air Force Space Command, Point Paper on Arch Chemicals, Inc. Hydrazine Production, Peterson AFB, CO, 2001.
- ¹³ Arch Investor Relations, “Arch Chemicals, Inc. Reports 3rd Quarter Results”, Investor Information, 31 Oct 2001, <<http://www.shareholder.com/arch/news/20011031-63442.cfm?t=e>> [5 Jan 02], 1.
- ¹⁴ Air Force Space Command, 45th Space Wing Operational Readiness Inspection Report, 15-26 May 2000, 31.
- ¹⁵ Robert S. Dudley, “The New Space Plan”, Air Force Magazine, Jul 98, 2.
- ¹⁶ Department of Defense, Report of the Commission to Assess United States National Security Space Management and Organization, (Washington, DC: 11 Jan 01), 28.
- ¹⁷ Department of Defense, Report of the Commission to Assess United States National Security Space Management and Organization, (Washington, DC: 11 Jan 01), 26.
- ¹⁸ Orbital Sciences, “Pegasus”, Orbital Sciences Corporation, 6 Jan 02, <<http://www.orbital.com/LaunchVehicles/Pegasus/pegasus.htm>> [6 Jan 02], 1.
- ¹⁹ Theresa Foley, “Space: 20 Years Out”, Air Force Magazine, Feb 00, 1.

BIBLIOGRAPHY

- 30th Space Wing Public Affairs Office. "Vandenberg AFB History", Vandenberg AFB Directory, 1998, I.
- Air Force Space Command. Instruction 10-1213, Spacelift Launch Strategy and Scheduling Procedures, Peterson AFB, CO, 2 Oct 00, 8.
- Air Force Space Command. Point Paper on Arch Chemicals, Inc. Hydrazine Production, Peterson AFB, CO, 2001.
- Air Force Space Command. 45th Space Wing Operational Readiness Inspection Report, Peterson AFB, CO, 2000, 31.
- Arch Investor Relations. "Arch Chemicals, Inc. Reports 3rd Quarter Results", Investor Information, 31 Oct 2001, <<http://www.shareholder.com/arch/news/20011031-63442.cfm?t=e>> [5 Jan 02].
- Dowhan, Mark E. <mark.e.dowhan@Boeing.com> "RE: We're Here" [E-mail to Robert Stanley fourboilers@earthlink.net] 22 January 2002.
- Dudney, Robert S. "The New Space Plan", Air Force Magazine, (Jul 98): 1,2.
- Dunn, Marcia. "Space Center Workers Feared Water More Than Wind", CNEWS – Canada's Internet Network, 15 Oct 99, <http://www.canoe.ca/CNEWSspace9910/15_floyd.html> [4 Jan 02].
- Estes, Howell M. III General. "What's in a Name", An Address to International Air Power Symposium, 24 Apr 97, <www.spacecom.af.mil/hqafspc/library/speeches/24apr97.htm> [3 Jan 02].
- Foley, Theresa. "Space: 20 Years Out", Air Force Magazine, (Feb 00): 1.
- Lambeth, Benjamin S. The Transformation of American Air Power, New York, NY: Cornell University Press, 2000.
- Minister of Public Works and Government Services, Canada. "NAVWAR Development", Canadian Forces Avionics Acquisition Plan: NAVWAR, 1999, <http://www.airforce.forces.ca/cfaap/eng/navwar/navwar_e.htm> [18 Jan 02].
- Orbital Sciences Corporation. Pegasus, 6 Jan 02, <<http://www.orbital.com/LaunchVehicles/Pegasus/pegasus.htm>> [6 Jan 02].
- Rumsfeld Space Commission. "Executive Summary", Report of the Commission to Assess United States National Security Space Management and Organization, 11 Jan 01, 15, 28.
- Tedino, Joseph. "NASA Just Says No to Insurance", Space.com, 4 October 99, <http://www.space.com/news/insurance_991001.html> [5 Jan 02].
- Security Classification of This Page Unclassified**

NOTES

-
- ¹ Department of Defense, Report of the Commission to Assess United States National Security Space Management and Organization, (Washington, DC: 11 Jan 01), 15.
- ² Robert S. Dudley, “The New Space Plan”, Air Force Magazine, Jul 98, 1.
- ³ Theresa Foley, “Space: 20 Years Out”, Air Force Magazine, Feb 00, 1.
- ⁴ General Howell Estes, “What’s in a Name”, An Address to International Air Power Symposium, 24 Apr 97, <<http://www.spacecom.af.mil/hqafspc/library/speeches/24apr97.htm>> [3 Jan 02].
- ⁵ Benjamin S. Lambeth, The Transformation of American Air Power, (New York, NY: Cornell University Press, 2000), 246-247.
- ⁶ Minister of Public Works and Gov’t Services, Canada, “NAVWAR Development”, Canadian Forces Avionics Acquisition Plan: NAVWAR, 1999, <http://www.airforce.forces.ca/cfaap/eng/navwar/navwar_e.htm> [18 Jan 02], 1.
- ⁷ Air Force Space Command, Instruction 10-1213 - Spacelift Launch Strategy and Scheduling Procedures, 2 Oct 00, 8.
- ⁸ Dowhan, Mark E. <mark.e.dowhan@Boeing.com> “RE: We’re Here” [E-mail to Robert Stanley fourboilers@earthlink.net] 22 January 2002.
- ⁹ 30th Space Wing, Vandenberg AFB History, (Vandenberg AFB, CA: 30th Space Wing Public Affairs Office, 1998), I.
- ¹⁰ Marcia Dunn, “Space Center Workers Feared Water More Than Wind”, CNEWS – Canada’s Internet Network, 15 Oct 99, <http://www.canoe.ca/CNEWSSpace9910/15_floyd.html> [4 Jan 02], 1.
- ¹¹ Joseph Tedino, “NASA Just Says No to Insurance”, Space.com, 4 October 99, <http://www.space.com/news/insurance_991001.html> [5 Jan 02], 1.
- ¹² Air Force Space Command, Point Paper on Arch Chemicals, Inc. Hydrazine Production, Peterson AFB, CO, 2001.
- ¹³ Arch Investor Relations, “Arch Chemicals, Inc. Reports 3rd Quarter Results”, Investor Information, 31 Oct 2001, <<http://www.shareholder.com/arch/news/20011031-63442.cfm?t=e>> [5 Jan 02], 1.
- ¹⁴ Air Force Space Command, 45th Space Wing Operational Readiness Inspection Report, 15-26 May 2000, 31.
- ¹⁵ Robert S. Dudley, “The New Space Plan”, Air Force Magazine, Jul 98, 2.
- ¹⁶ Department of Defense, Report of the Commission to Assess United States National Security Space Management and Organization, (Washington, DC: 11 Jan 01), 28.
- ¹⁷ Department of Defense, Report of the Commission to Assess United States National Security Space Management and Organization, (Washington, DC: 11 Jan 01), 26.
- ¹⁸ Orbital Sciences, “Pegasus”, Orbital Sciences Corporation, 6 Jan 02, <<http://www.orbital.com/LaunchVehicles/Pegasus/pegasus.htm>> [6 Jan 02], 1.
- ¹⁹ Theresa Foley, “Space: 20 Years Out”, Air Force Magazine, Feb 00, 1.