The Space and Air Force

One Pathway to the Future

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The United States Air Force leadership recently made an official statement that it is "now transitioning from an air force into an air and space force on an evolutionary path to a Space and Air Force."[1] This statement raises many questions for the U.S. national security community. What operational challenges and threats could emerge in the future that might compel the Air Force to migrate many critical missions currently performed in the air environment into the space environment? What systems and technologies might a "Space and Air Force" consist of? How would such a force operate? This paper represents one potential "pathway" or "alternative future" that could lead to the development of the "Space and Air Force." Undoubtedly, entirely different pathways could be developed using different assumptions, threats, and operational concepts. The Space and Air Force depicted below is a product of pronounced changes in the threats to both the U.S. and its interests abroad along with the recognition of considerable operational shortcomings and existing vulnerabilities in the current U.S. force structure. This pathway does not take into account future budgetary constraints, but assumes that the emerging threat environment demands a significant shift in resources from traditional air, land, and sea systems and operations to space systems and operations. This paper was originally prepared as an input to an Air Force-sponsored seminar called "Transforming Space Operations."

Introduction

In the early years of the 21st Century, potential U.S. adversaries embraced a number of new operational and technical measures that compelled the U.S. Air Force to significantly alter its force structure, doctrine, and strategy. The enemy "measures" that instigated change in the Air Force, many of which were asymmetrical to U.S. military capabilities, included: [1] the integration of ballistic and cruise missiles, weapons of mass destruction (WMD), and long-range, surface-to-air missile (SAM) systems into operational concepts designed to prevent the timely deployment of U.S. air and ground forces into in- and near-theater air bases and ports; [2] the development and/or acquisition of intercontinental ballistic missile (ICBM) systems capable of striking the United States by a variety of new adversaries; and [3] the ability to destroy U.S. space assets with relatively crude anti-satellite (ASAT) systems.

In order to counter these adversaries most effectively, the Air Force adopted an aggressive program to transition from a force structure and doctrine based primarily on air power to a force designed to take advantage of the unique characteristics that the medium of space offers. In so doing, the "new" Air Force (now referred to as the *Space and Air Force*) elected to go beyond the traditional space missions of providing secure and assured sensing, navigation/targeting, and communications support to the warfighter and the National Command Authority and to actively exploit the full potential of space through weaponizing the "high frontier."

The *Space and Air Force* is centered on both permanently space-based sensors/weapons systems and space-transiting vehicles that have been tasked with achieving critical U.S. operational and strategic objectives in times of war. Theater-based aircraft are quickly being replaced by Spaceplanes and long-range, cruise missile-carrying aircraft that do not require in-theater basing, do not need to penetrate enemy air space, and have smaller logistics "tails." Advanced space-based sensor networks and unmanned air vehicles (UAVs) have replaced the earlier manned airborne sensor platforms such as JSTARS and AWACS.

With the "migration" of large elements of the force into space, the primary missions of the Service have become space control (which includes performing friendly space asset protection while also holding hostile spacecraft at risk), long-range precision strike/ interdiction, and space support to terrestrial forces. In essence, the *Space and Air Force* represents a major shift in the manner and means through which the U.S. achieves its strategic objectives. Instead of relying heavily on short-range, manned air systems, forward bases, and lengthy deployment timelines, the U.S. has elected to depend on the global presence, more rapid response, high lethality, and deterrent qualities provided by global strategic aerospace forces.

In terms of traditional mission areas, air superiority continues to be important, but is achieved for different purposes and by new forces. As Spaceplanes and cruise missile carrier planes replace theater-based aircraft in the long-range strike role, the suppression of enemy air defenses (SEAD) is required to facilitate penetration by cruise missiles rather than manned aircraft (even bombers, for the most part, now carry cruise missile payloads). Whereas combinations of electronic warfare aircraft and fighters performed SEAD in a potentially risky and costly manner in the past, enemy surface-to-air missile radar sites are now neutralized by long-range, hypersonic, anti-radiation missiles. Only loitering, high-altitude UAVs and stealthy bombers, tasked with detecting and destroying enemy ballistic missile transporter/erector/launchers (TELs), need to penetrate enemy air space.

Permanent control of friendly air space (including both U.S. and allied air space) continues to be a critical mission and is achieved through a combination of space, ground, sea, and air systems. Achieving control consists primarily of defending against ballistic and cruise missiles and aircraft to protect both the U.S. homeland and forward-deployed ground elements of the force. Close air support of in-theater ground units has been ceded completely to the *Ground and Air* component of the joint force.

Threat Environment Compels Shift from Air to Space

In order to understand the Air Force's shift to a *Space and Air Force*, it is important to examine the development of the threat environment early in the 21st Century. This environment was marked by the decision on the part of many adversaries to build missile-based force projection systems (including ICBMs, theater ballistic and cruise missiles, and ASATs) as an effective means to counter U.S. force structure and military strategy.

Early in the 21st Century, U.S. power projection forces centered on U.S.-based air and ground forces that required considerable time to deploy to areas of conflict. Since the vast majority of the air systems had particularly short combat ranges (except the heavy bombers), they depended on the availability and survivability of air bases and aircraft carriers that had to be situated within relatively short ranges of their targets (in other words, in close proximity to the enemy). Potential adversaries observed this dependency of U.S. systems on fixed, in-theater air bases and aircraft carriers afloat during the Persian Gulf War and accordingly began to develop weapon systems and concepts that could deny such critical assets to the U.S. military. They found solutions in both theater ballistic and cruise missiles that could be launched against air bases prior to the entry of U.S. air forces into theater and in sea-skimming, supersonic, anti-ship cruise missiles, mines, and submarines that could threaten the aircraft carriers. The missiles targeted at air bases could deliver warheads carrying high explosives or WMD in either unitary or submunition form. Since U.S. theater missile defenses (TMD) resided in ground-, air-, and sea-based platforms, they too had to deploy to the theater and therefore often were not available to counter preemptive missile strikes against their own ports of entry. Essentially, adversaries had found a means to get "inside" U.S. operational timelines (based largely on deployment timeline requirements) and degrade/destroy the basing deemed so critical to the conduct of U.S. offensive and defensive operations. If the U.S. military could be kept out of a theater for a long enough period of time, an adversary could potentially obtain the time needed to achieve its strategic objectives and present the U.S. with a fait accompli. In such situations, the U.S. could be left with choosing between engaging in a very costly and risky conflict (measured in time, casualties, and money) or refusing to fight altogether.

In addition, the proliferation of advanced SAM systems among both peer and regional competitors made it increasingly difficult for non-stealthy U.S. aircraft to penetrate enemy air space to perform their missions. Advanced SAMs, especially those that had been built by the Soviets, were capable of inflicting serious losses on U.S. air assets. As a result, the SAMs could delay U.S. offensive strike operations since considerable time and effort would likely be needed to suppress them. The U.S. operational timeline dilemma (which accentuated serious military disadvantages in time, distance, and mass), combined with the proliferation of advanced surface-to-air missile systems, compelled the Air Force to look for new operational and technical alternatives to deal with theater conflicts in the future.

Next, the leadership of the United States (as it had throughout the Cold War) had continued to balk at building and deploying a defense for the United States against

ICBMs. Although it began to build a limited national missile defense in 2005 in response to the acquisition of ICBM capabilities by several regional competitors, the operational system consisted of only 100 interceptors (based at one site) and was not completed until 2008. At this time, enemy ICBM capabilities had expanded considerably, and the U.S. recognized that it needed a more capable missile defense architecture that could not only respond effectively to the ballistic missile threat worldwide, but also that might deter enemy launches of WMD payloads altogether.

As a result of the critical role that satellites played in the Persian Gulf War, the U.S. military continued to increase its dependence on space-based assets for communications, navigation/targeting, and sensing support. By 2005, almost all U.S. precision-guided munitions used Global Positioning System (GPS) targeting data; all ground units were equipped with hand-held, satellite navigation and communication devices; and space-based intelligence was transmitted directly to the warfighter at the tactical level ("sensor-to-shooter" connectivity). The National Missile Defense (NMD) system relied heavily on launch detection and mid-course tracking and discrimination data provided by a three-teired constellation of Space-Based Infrared Satellites (SBIRS). Essentially, space-based capabilities had become a pivotal center of gravity that leveraged the entire U.S. force structure across almost all mission areas. Adversaries observed this growing dependency and began to develop capabilities to contest the U.S. use of space, including rudimentary, direct-ascent, kinetic-kill ASATs. U.S. intelligence also suspected that, should the need arise, several countries could detonate nuclear tipped missiles in low Earth orbit (LEO) for the purpose of negating (or at least diminishing) U.S. space-based capabilities. On account of the vulnerability of U.S. space capabilities to emerging threats, the Air Force decided to pursue the means to actively protect the U.S. space order of battle.

The Move to Space

In order to counter this emerging threat environment and to provide the most effective and efficient means to achieve U.S. strategic objectives, the Air Force initiated a transition from an air-dominated force to a space-dominated force. Aware of the existence of considerable resistance to the weaponization of space and a continued adherence to the ABM Treaty in the United States, the Air Force and the Department of Defense (DoD) initiated a comprehensive campaign to outline the shortcomings of these positions and to explain the reasoning behind expanding warfare into the space environment.

The Air Force emphasized that the creation of a new warfare area -- space warfare (based on the weaponization of space) -- was comparable to the development of air warfare early in the 20th Century, which originated when combatants began to exploit the altitude and speed advantages provided by air operations. In making the case for weaponizing space, the Air Force stressed that the superior altitude, speed, and vantage characteristics of space could enable permanent, but unobtrusive, global presence during peacetime and make faster (or in some cases immediate) response to enemy actions possible.

The Space Triad

Substantial advances made in propulsion, high-performance and lightweight materials, adaptive and lightweight optics, laser technologies, hyperspectral sensors, distributed radar networks, and battle management/command, control and communications (BMC^3) systems enabled the shift from an air-dominated force to a space-dominated force. These technologies allowed the *Space and Air Force* to both fully exploit the militarily unique characteristics of space and to provide better quality information support for the other segments of the joint U.S. force.

The *Space and Air Force* was founded on a "triad" of space systems, each capable of performing multiple missions, that are mutually supportive of each other. The unique synergies between the three systems required that they be developed and deployed in tandem, rather than independently. The first "leg" of the triad is a squadron of six Spaceplanes (also called Trans-Atmospheric Vehicles), which are single-stage-to-orbit, fully reusable launch vehicles, whose central tasks are launching small- to mid-size satellites into low-Earth or transfer orbits and conducting long-range precision strikes against ground targets from space. The Spaceplanes, designed to operate like aircraft, are capable of flying up to three sorties per day and are easily mated with modular weapon or satellite payloads. This space vehicle gives the U.S. military unparalleled access to space, without which the move to operationalize space would have been near impossible.

The second "leg" of the triad is a network of 24 high-energy, chemical Space-Based Lasers (SBL) permanently based in 1300-kilometer orbits, dually tasked with the global boost-phase intercept of TBMs and ICBMs and achieving/maintaining space control. Space-Based Lasers possess a mid-infrared wavelength capable of penetrating the atmosphere with weapons-class performance as low as 35,000 feet above the Earth's surface (can begin to engage boosting ballistic missiles shortly after cloud break). SBLs are orbited by NASA/DoD heavy launch vehicles while Spaceplanes are tasked with on-orbit refueling of the laser reactants and satellite propellants. The SBLs also can perform global, high fidelity (less than one-meter resolution) optical surveillance when not engaging enemy targets.

The final "leg" of the triad is a distributed Space-Based Radar (SBR) network capable of performing the global detection and tracking of both moving and stationary ground, sea, and air threats, including low observable vehicles. The SBR can directly task friendly air and space assets best able (or positioned) to intercept a given threat. The SBR has proved most valuable in improving the U.S. ability to: [1] detect low observable aircraft and cruise missiles and track them at an update rate that best supports intercept by air-, ground-, and sea-based weapon systems; and [2] detect theater ballistic missile transporter, erector, launchers (TELs) -- sometimes before they launch their missiles -- and cue long-range precision strikes by loitering UAVs and stealthy bombers against them. The SBR replaced a number of systems in the U.S. force structure including AWACS, JSTARS, E-2Cs, and several ground-based radar and early warning systems.

Additional pieces of the space component of the *Space and Air Force* include: a small constellation of hyperspectral sensors that can distinguish individual substances or materials; the aforementioned network of infrared launch detection, tracking, and discrimination satellites; advanced SIGINT satellites; and an advanced communications infrastructure comprised of large numbers of high data rate, wide bandwidth military and commercial communications and data relay satellites.

Operational Concepts

While advanced technologies propelled the transition from "air-dominated" to "space-dominated" operations, it was the development of new operational concepts through the innovative integration of space and air systems that enabled the *Space and Air Force* to respond most effectively to the emerging warfare environment. The concepts are based, first and foremost, upon providing permanent global presence, immediate (or near-immediate) reaction/engagement capability, and comprehensive defense of the United States and its allies. Further, the concepts include sufficient flexibility and lethality to respond across the spectrum of military conflict. The combination of these elements is believed to credibly deter adversaries from initiating military actions deemed contrary to U.S. vital interests at both conventional and unconventional (nuclear, biological, chemical) levels. If deterrence fails, though, the *Space and Air Forces*, when integrated with the *Naval and Air* and *Ground and Air* components of the joint force, are designed to respond quickly, with high lethality and accuracy, in order to defeat enemy forces with limited friendly casualties. In short, the critical phases of the *Space and Air Force* operational concept, regardless of adversary, are:

> *Phase 1 (continuous): Provide space support to the warfighter and National Command Authority (NCA)*

The *Space and Air Force* is responsible for the continuous operation, support, and command and control of the U.S. space-based information collection and dissemination architecture. This architecture provides timely information to the joint force (in peacetime and in wartime) including targeting, positioning, battle damage assessment, detection and tracking of WMD, launch detection, and other types of intelligence critical to conducting military operations. A critical element of operating the space architecture is performing the rapid replacement of space systems that are damaged through natural causes or combat.

The *Space and Air Force* itself is extremely dependent on continuous battlespace knowledge. In order to detect and to respond immediately to surprise (preemptive) attacks, the force relies on the distributed Space-Based Radar to continuously monitor the movements of all critical enemy vehicles. The system is capable of keeping U.S. commanders informed of revelatory signs of pending enemy actions such as missile TELs leaving their garrisons, the massing of armored, amphibious, or air assault vehicles, or the deployment of strike aircraft to forward air bases. The SBR, complemented by infrared launch detection satellites, will also detect initial salvos of ballistic and cruise missiles and immediately begin to cue in-theater and space-based

missile defense systems. Space-based hyperspectral sensors can assist in monitoring the movement of weapons of mass destruction.

The space-based BMC3 architecture enables near-real time, sensor-to-shooter connectivity. This network is streamlined so that it passes through the fewest layers of command hierarchy possible before it is sent to the shooters. Such connectivity allows for the full exploitation of time-sensitive intelligence collected by space-based sensors. In the unique case of the time-sensitive missions of ballistic and cruise missile defense, Space-Based Lasers operate in an autonomous mode to engage enemy missile threats launched from defined geographical "hot" spots (including the territories of any designated adversaries and all bodies of water). The BMC3 architecture relies on both military and commercial space-based, high data rate, relay networks to transmit vital strategic-, operational-, and tactical-level communications.

Phase 2 (M-minute Þ): Achieve and maintain space control

Achieving space control is undertaken primarily by Space-Based Lasers that can attack suspected enemy on-orbit space weapons in relatively short order or intercept direct-ascent ASATs launched against U.S. military space systems and critical commercial communications networks. Long-range precision strike assets, such as Spaceplanes and cruise missiles, also contribute to the space control mission by neutralizing enemy satellite downlink stations, launch sites, and command and control nodes.

By and large, the *Space and Air Force* operational concepts do not call for the permanent destruction of any space-based commercial space assets that U.S. adversaries might exploit during conflict. This condition exists for several reasons. First, the U.S. military utilizes many of the same commercial telecommunications and sensing networks as the adversary and neutralizing them would, more often than not, serve to impede U.S. operations more than the adversary. Next, the U.S., of course, is reluctant to damage satellite networks that are operated or used by allies and/or neutrals throughout the world. Lastly, in many cases the U.S. military considers the dissemination of available commercial space-based imagery to be not responsive enough to pose a major threat to the U.S. force structure as it becomes smaller, faster, stealthier, more mobile, and predominantly air- and space-based. However, in situations where the U.S. military concludes that certain commercial systems must be degraded, the preferred courses of action are either the near-immediate destruction of terrestrial downlink stations or any of a number of non-lethal ASAT measures (including uplink jamming, localized Global Positioning System (GPS) signal spoofing, and sensor blinding).

These space control concepts, however, are not foolproof. Accordingly, all U.S. military satellites are radiation-hardened and possess adequate fuel supplies for conducting considerable orbital maneuvers (LEO satellites can also be refueled by Spaceplanes). If critical satellites are lost during the course of a conflict, Spaceplanes can replace them quickly with small, modular, tactical satellites (TacSats) that serve as temporary "stopgaps" until permanent replacement satellites can be launched. A robust space- and ground-based space surveillance network supports the space control mission by

providing near-real time space object identification, fire control-quality target tracking, and battle damage assessment.

Phase 3 (M-minute Þ): Theater and national missile defense

The *Space and Air Force* plays a central role in a tiered (layered) theater missile defense architecture tasked with protecting critical in-theater air bases and ports and friendly populations from enemy ballistic and cruise missile attack. First, Space-Based Lasers perform global intercept of theater ballistic missiles in the boost-phase. Boost-phase is the optimal time to perform the intercept of a TBM for a number of reasons: [1] the enemy missiles are easy to detect on account of their bright plume; [2] they are traveling at the slowest speeds of their trajectory; and [3] the missiles are under high aerodynamic and kinematic stresses. Even more importantly, a credible and survivable boost-phase intercept capability could deter an adversary from launching nuclear, biological, or chemical warheads altogether on account of the possibility that these warheads might fall back on the adversary's homeland.

Once stealthy, high-altitude UAVs and bombers reach the theater, they penetrate enemy air space and perform precision strikes against enemy ballistic and cruise missile TELs with hypersonic kinetic kill vehicles. Although the Space-Based Radar can direct the UAVs towards enemy TELs, the UAVs have on-board capability to backtrack a boosting ballistic missile to its origin and thereby pinpoint the associated TEL. The *Naval and Air Forces* of the Joint Task Force also possess UAVs to contribute to the TEL hunting and destroying missions.

The Space-Based Radar can also perform early detection of low-flying cruise missiles, track them continuously, and cue fighter aircraft, *Aegis* ships, or ground-based missile defense systems best positioned and equipped to intercept them.

The *Space and Air Force* also contributes to the terminal phase intercepts performed by ground- and naval-based TMD systems and the ground-based NMD system. The Space-Based Infrared Satellites continue to track enemy ballistic missiles and reentry vehicles during the mid-course phase of flight and discriminate between warheads and penetration aids, which improves the ability of ground-launched interceptors to find and engage the actual threats. If necessary, the Space-Based Laser can negate penetration aids, such as balloons, during the mid-course and thermally "tag" reentry vehicles to improve the probability of kill of passive, infrared-seeking exoatmospheric interceptors.

Phase 4 (H+1 Þ): Long-range precision strikes from space

Spaceplanes are tasked with conducting near-immediate precision strikes against critical enemy centers of gravity including lead elements of his offensive forces, command and control nodes, and ground-based telecommunication facilities in order to achieve one of two goals: [1] cause sufficient damage early enough in the campaign to deter further enemy offensive operations; or [2] at least slow the enemy offensive until additional U.S. precision strike and maneuver forces can reach the theater. Spaceplanes can be mated with a GPS-guided, reentry glide vehicle filled with brilliant munitions and

sensor-fused weapons for missions against enemy armored units. To ensure destruction of fixed, area targets such as critical command and control nodes or utilities, the Spaceplanes can be equipped with payloads of titanium "rods."

Phase 5 (H+10 Þ): Long-range precision strikes from space, air, and sea

While the Spaceplanes can provide near-immediate response to enemy attacks, they likely cannot provide operationally significant numbers of sorties to defeat or deter a determined and militarily robust adversary. Accordingly, the *Space and Air Force* relies on heavy bombers and large, cruise missile-carrying aircraft to continue strikes employing thousands of warheads against critical enemy centers of gravity and fielded forces in conjunction with cruise missile platforms (such as arsenal ships, submarines, and *Aegis*) from the *Naval and Air Force* arm of the joint force. The air- and sea-launched cruise missiles can be equipped with unitary high explosives, submunitions, brilliant or area munitions to attack armored formations, or penetrator warheads to eliminate some hardened or buried targets. Meanwhile, Spaceplanes can be redirected to strike deep underground (DUG) facilities with hypersonic penetrator weapons made of titanium or depleted uranium in this phase of the campaign.

Phase 6 (D+1 Þ): Maneuver forces perform additional offensive combat operations

The arrival of the *Ground and Air* component of the Joint Task Force in theater marks the last phase of the campaign. These highly mobile and flexible air and ground forces are tasked with safeguarding critical air bases, ports, C2 nodes, and population centers and perform additional offensive combat operations against the enemy attack force. Heavier units in the *Ground and Air Force* can subsequently enter the theater for the purpose of securing the peace and restoring the status quo ante bellum if required by the National Command Authority.

Postlogue

The systems and concepts described in this article are representative of those that could be employed by a future *Space and Air Force*. As mentioned at the beginning, alternate sets of assumptions and threats could entail the development and deployment of entirely different space systems and operational concepts. However, what seems clear is that the emerging threats in the future warfare environment are becoming longer in range, harder to find, and greater in lethality and destructiveness. Potential adversaries are developing and acquiring the means to threaten not only U.S. forces abroad, but also U.S. citizens at home. In order to counter such threats effectively, it is likely that the United States Air Force will have to undergo a difficult, yet essential, transition into a *Space and Air Force*. The global presence, near-immediate responsiveness, and energy advantages provided by space-based and space-transiting systems will prove critical to effectively countering America's future adversaries.

When available technology enabled man-made vehicles to transit the Earth's atmosphere over great distances, a bold and innovative group of individuals, confronted

by considerable resistance from within and without the military, sought to exploit the advantages inherit in this "high ground." Today, the Air Force has arrived at a similar junction, except the "high ground" is space. It will take time and perseverance to make the difficult transition to a space-dominated force, but, as the requirement for supreme air power demonstrated, the full exploitation of the space environment will prove paramount to providing for this nation's security.

Note

1. Global Engagement: A Vision for the 21st Century Air Force, a Department of the Air Force White Paper, Washington, D.C., 1977; p. 7 (emphasis included in the original document).

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