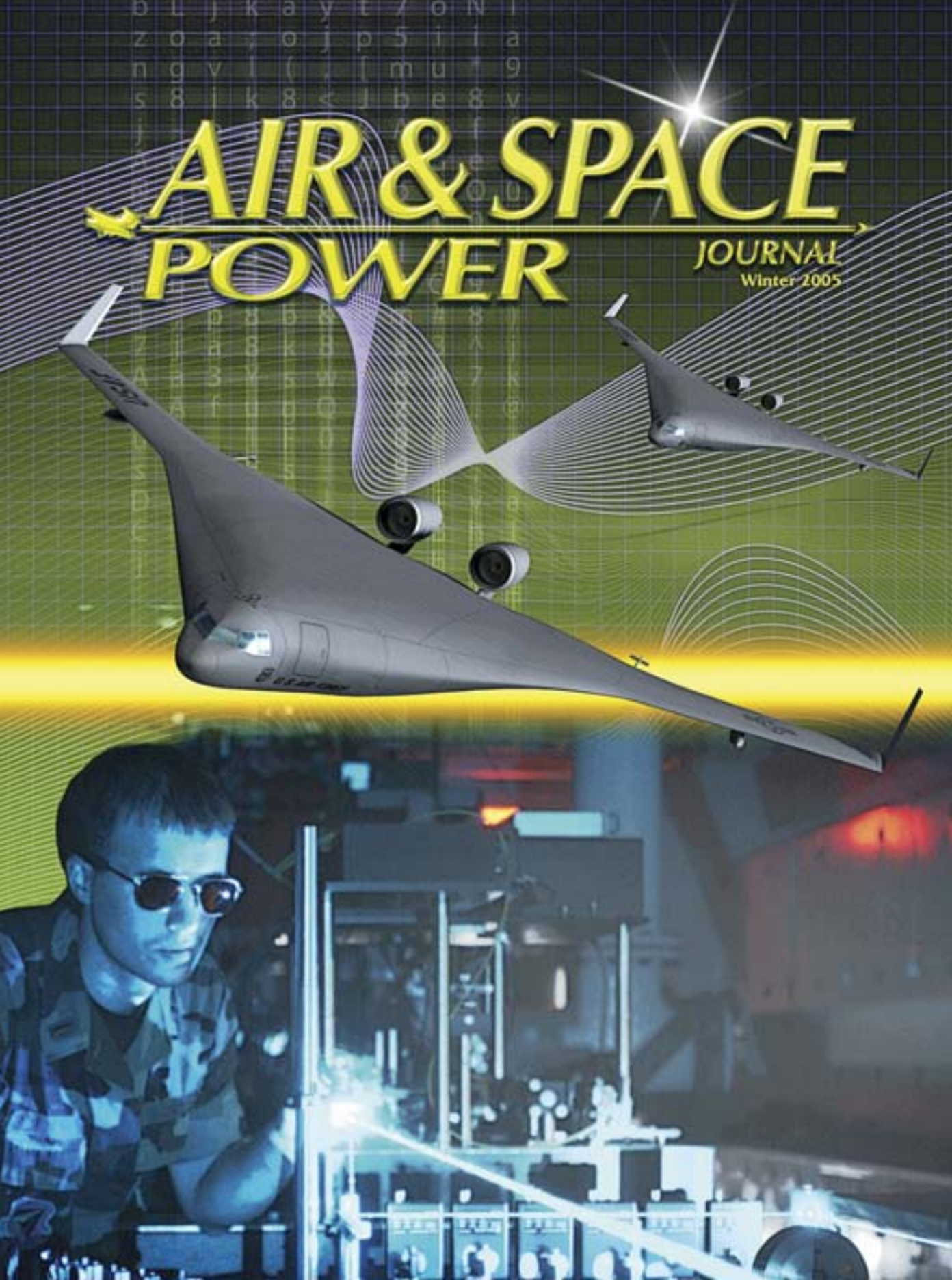
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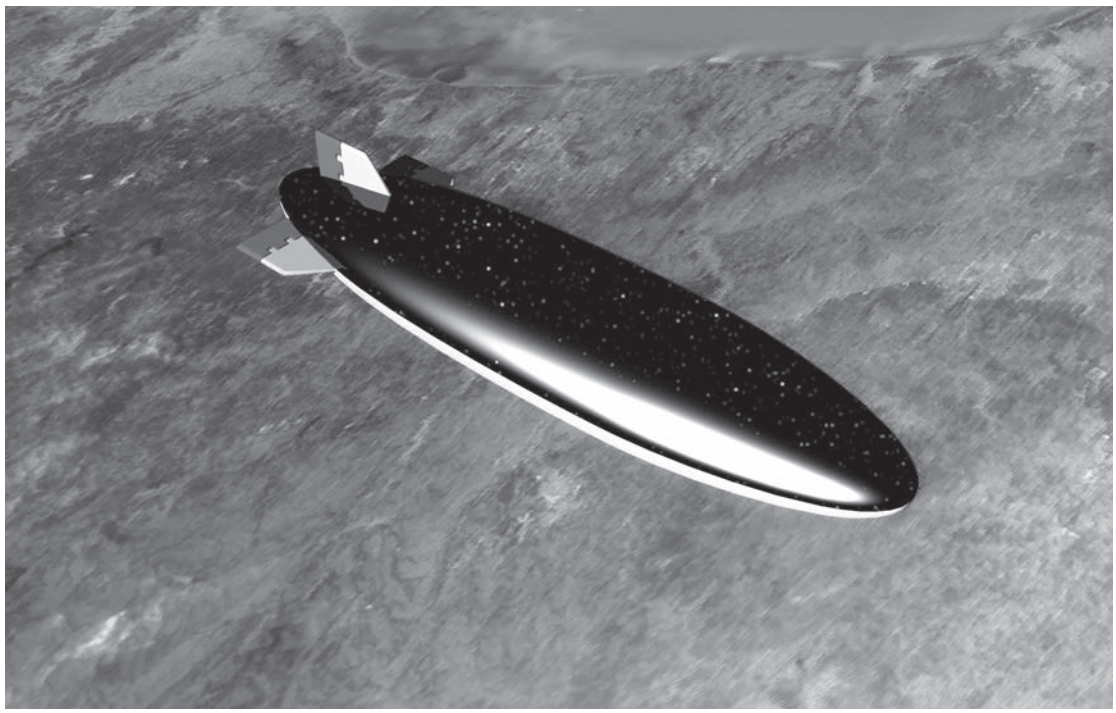
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Balloons in Today's Military?

An Introduction to the Near-Space Concept

Lt Col Ed "Mel" Tomme, USAF
Col Sigfred "Ziggy" Dahl, USAF

Editorial Abstract: The near-space region is emerging as an important operational domain for the war fighter. This article is derived from a larger, more fully documented treatise on near-space operations entitled The Paradigm Shift to Effects-Based Space: Near-Space as a Combat Effects Enabler, *available at the Web site of Maxwell Air Force Base's Airpower Research Institute: https://research.maxwell.af.mil/papers/ay2005/ari/CADRE_ARI_2005-01.pdf.*



We choose to . . . do the other things, not because they are easy, but because they are hard.

—John F. Kennedy
President of the United States, 1962

MILITARY COMMANDERS MUST know, intrinsically, the nature of their battlefields and be able to act swiftly and decisively to changes in that environment. There is nothing new about this fact. History is overflowing with examples of the victory or defeat resulting directly from it.

Twenty-four June 217 BC: As the early rays of dawn crested the steep hills surrounding the crystal blue waters of Lake Trasimene, Roman proconsul Caius Flaminius pulled his heavy cloak closer about his shoulders. A thick fog blanketed the lush plain that held his magnificent, 25,000-strong Roman army. Flaminius, a cunning hunter, was herding his archenemy Hannibal Barca with his advancing troops. A patient general, Flaminius knew better than to engage the wily Hannibal, who was still more than a day's hard ride to the southeast, until the time and conditions were right.

His advisors had urged him to send scouts out in advance of his main body, but Flaminius was concerned about revealing his exact position and thought it better to let Hannibal guess. He knew that Hannibal would soon be caught between the jaws of two formidable Roman forces and defeated once and for all. The Roman general had seen the campfires of the Carthaginians in the distant hills the preceding evening. He thought scouts were completely unnecessary in these conditions and could only work against him. Flaminius was badly misinformed.

High upon a hill, Hannibal Barca watched the barely visible Roman standards as they moved ghostlike through the fog that blanketed the valley below. Hannibal had arrayed his army in such a way as to block egress through the winding trail that cut through the pass to the east, but kept his main fighting force of Iberians and Africans quietly camped on the steep hillsides amongst the boulders and scrub trees.

This was the second morning that Hannibal had been camped in this natural amphitheater, and he had noted the dense morning mists the day prior. His men were less than a half mile from the elite Roman troops, poised for a sudden attack. He sent the command to execute a close-phased attack with signals easily seen from the high hilltops. Moving through the fog, the Roman army had no warning as the Carthaginian masses sliced into them from above. Before noon, Flaminius, along with 15,000 of his warriors, lay dead. Many thousands more were captured or wounded. "How could this possibly be?" the Roman must have thought. Hannibal knew the values of a robust intelligence network, meteorology, long-range communications, and most importantly, the inherent advantage of owning the high ground.

Jump forward 2,222 years: what would you say if we told you the US military was seriously considering augmenting its intelligence-gathering and communications infrastructures with helium-filled balloons? You would probably say we were crazy. However, it is true, and once we get past the "giggle factor," we think you will agree that the concept has a lot of merit. Like Hannibal, our leaders also know the value of a robust intelligence network, meteorology, long-range communications, and the inherent advantages of owning the high ground, and we are moving out sharply to capitalize in this regime.

The near-space concept, as it is currently called, involves floating payloads into a region of the stratosphere where winds are light and weather virtually nonexistent. From that extremely high vantage point, the payloads have line of sight for hundreds of miles to the horizon, becoming long-range communications relays or providing intelligence over theater-sized areas. The purpose of this article is to show why the near-space concept can become a valuable layer in our nation's system of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems, with strengths that the other layers do not or cannot provide. The reason we call it near-space is that it provides similar effects to what satellites have traditionally given us without having to go into orbit. Others prefer to call it "far-air." It really does not matter. After all, what is in a name? It is a medium that we need to exploit to get space effects.

Many functions that are currently done with satellites could be performed, for tactical and operational commanders, using near-space

assets more cheaply and with greater operational utility. To fully understand this fact, one must be able to grasp what the word "space" means to the war fighter. Sadly, too many people define space as a *place* where we operate satellites. That mind-set is, in a word, counterproductive. Space is *not* just a place and is *not* based on a specific platform type. To the warrior, space is a medium from which war fighters get *effects*—the proverbial "ultimate high ground." If it has no direct effect on the battlefield, a war fighter has little use for it, especially in a time of crisis. Typically, space effects are strongly related to C4ISR. Until recently a large fraction of our C4ISR effects has been delivered from satellite platforms. The reason for operating in such a manner was that, in general, no other way existed to obtain similar effects. The extreme costs of space were easily justified due to the monopoly on the ability to provide the needed effects. However, with the advent of near-space concepts, the *same effects* can be obtained in a different way, especially for operational and tactical users. It is the individual effect that is paramount for the war fighter, not the platform or the environment where the platform resides. The *primacy* of the concept of space as a set of related effects, rather than a location or a set of platforms, is a true paradigm shift—and one long overdue.

The near-space operating regime has many strengths. It also has its own weaknesses. This article is a top-level comparison of how space effects can be delivered from near-space, satellites, manned ISR, and unmanned aerial vehicles (UAV). Satellites will be shown to have great strengths for strategic missions where freedom of overflight is required. However, for operational and tactical missions—primarily after or just before commencement of hostilities—we argue that near-space holds strong advantages. Near-space assets that can provide stay-and-stare persistence for days, months, and perhaps even years should soon be available. These mission durations will soon exceed those of UAVs and begin to approach those of satellites. Near-space provides persistence and proximity that orbital mechanics prohibits, with a price tag that space launch cannot approach.

It is important to note that we do not advocate replacing satellite assets with near-space assets. On the contrary, near-space allows our high-dollar strategic assets to do their jobs even better by relieving them of many of the stressors that tactical and operational commanders place on them during times of crisis.

A Dearth of Persistence

So why do we need to go to near-space? Four factors are significant: orbital mechanics, fuel, cost, and weather. These factors deny commanders the one thing they want most in a C4ISR system: stay-and-stare persistence. There are surprisingly few national ISR assets actually orbiting the earth. These assets are frequently needed for higher-priority missions and are so heavily tasked with strategic missions that they may not be readily available to operational or tactical commanders.

Similarly, communications resources, regardless of where the nodes are located, never seem to be available in sufficient quantity. Satellite-based communications are very expensive to field and generally have limited bandwidth and availability. Those assets with continuous availability are extremely expensive to build, and the costs of boosting them to their distant geosynchronous Earth orbits (GEO) put them well beyond the price range of operational and tactical commanders. The existing alternatives—terrestrial communications systems such as cell phone networks—are difficult and time consuming to set up and are not responsive on a moving battlefield. The currently fielded constellation of communications, navigation, and ISR satellites does an exceptionally good job of providing strategic space effects.

However, even as good as they are as currently envisioned and employed, it is impossible for our limited non-GEO assets to provide a constant, staring presence on a timescale of days, weeks, or months over a selected target or area of interest without fielding a much larger constellation of assets. Nongeostationary satellites measure their persistence in pass times instead of hours. For example, most low Earth orbit (LEO) satellites have a specific tar-

get in view for less than 10 minutes at a time and revisit the same sites only infrequently. This kind of persistence is stroboscopic at best. Costing billions or at least millions each, countering the strobe-like view with multiple satellites to provide staring persistence is almost prohibitively expensive. Additionally, satellites can only carry very limited amounts of maneuvering fuel, so their orbits and times overhead are very easily predicted—a fact many of our enemies exploit.

C4ISR space effects are also provided by air-breathing platforms. While much more responsive than orbital assets and capable of returning much higher resolution imagery, due to their limited numbers and limited loiter times, airborne assets still cannot always provide the persistent look needed by battlefield commanders.

Physical limitations due to orbital mechanics and fuel consumption prevent long-term persistence for both orbital and airborne platforms. As a result of being tied to expensive, limited-quantity platforms operating in the traditional media of space and air that do not have the capability to stay on station for extended periods of time, battlefield commanders have only a limited chance of tasking an asset that provides all the information or communications capability they need when and where they need it.

Space and Near-Space

Again, thinking about space as just a location or a set of platforms is an *artificial* constraint that distracts from the whole point of launching satellites into orbit—getting the desired effects for the war fighter. We do not launch satellites just to launch them—space launch is a very expensive proposition. We launch satellites only when we determine them to be the best way to get the desired effects related to their missions *in spite of* their costs.

From the above discussion, it is obvious that there is a gap in our ability to deliver persistent C4ISR effects. There is also a gap in the altitudes covered by military assets, as shown in figure 1. These two gaps can be simultaneously filled through the use of near-space platforms. Near-space platforms operating in the altitude gap can provide the missing persistent communications and ISR effects desired by war fighters.

Near-space is well below orbital altitudes. Being roughly defined as the region between about 65,000 and 325,000 feet, it is too low for sustained orbital flight and above the region where air-breathing engines and wings work very well. Operating in near-space offers a number of benefits. Some of these benefits are footprints approaching those of satellites, proximity to the war fighter, survivability, low cost, responsiveness, flexibility, and, above all, persistence. Although our definition of near-space reaches to the boundary of space, we cannot currently sustain operations throughout that entire region. We can, however, comfortably achieve long-term presence in near-space below about 120,000 feet. The lower limit of near-space was not only determined from operational considerations, being above controlled airspace, but meteorological ones as well. The 65,000-foot level is above the troposphere, the region of the atmosphere where most weather occurs. There are no clouds, thunderstorms, or precipitation in near-space. Turbulence and strong winds, the bane of large balloons at lower altitudes, are not the norm in near-space. In fact, there is a region between about 65,000 and 80,000 feet where average winds are less than 20 knots, with peak winds being less than 45 knots 95 percent of the time. Near-space is a much better place for lighter-than-air vehicles to operate than lower altitudes.

The footprint, the area in which the platforms can provide their space effects, covered by near-space assets, is very large. *Footprints are mission driven.* For example, the ground-based node of a ground-to-space (or ground-to-near-space) communications link generally requires the space-based link to be a specified angle above the horizon to ensure connectivity. The footprint for such a mission would be the area on the ground from where the platform would appear to be at least the specified angle above the horizon. To use two near-space platforms as nodes in a communications link

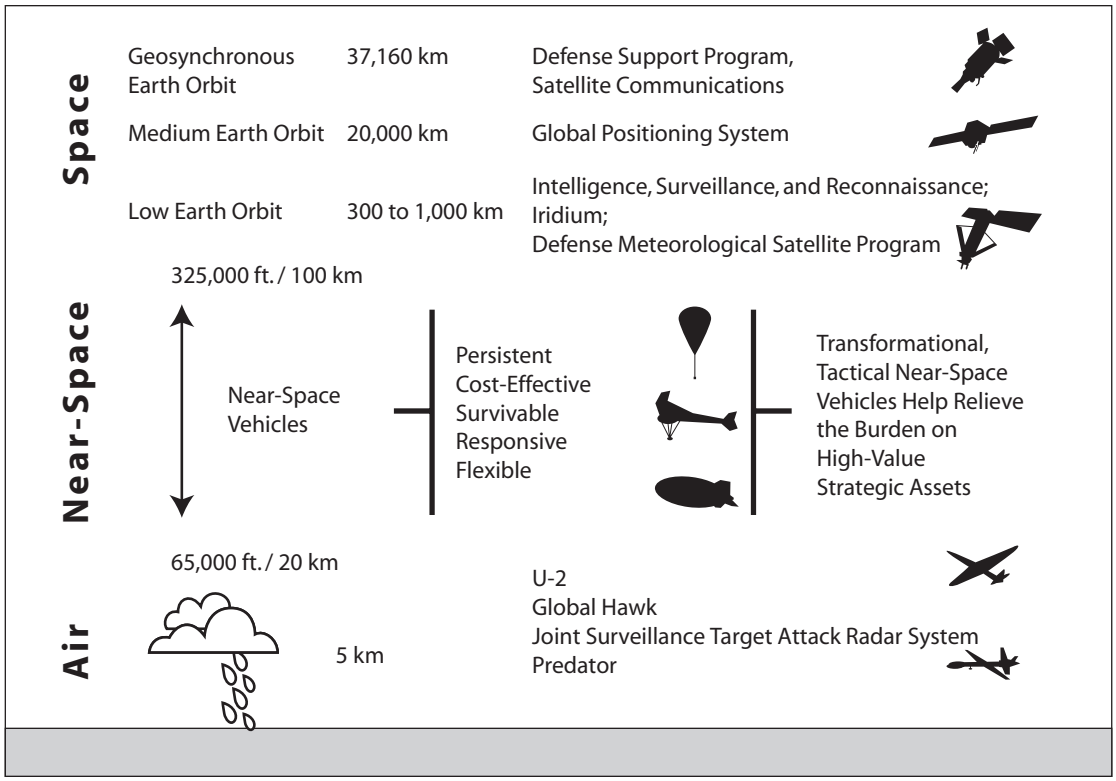


Figure 1. Graphical depiction of the gaps filled by near-space

requires an unobstructed line of sight between the two. In contrast, a signal detection sensor only needs line of sight to the signal source, so its footprint extends to the horizon as seen from the platform.

Figure 2 shows the extent of these footprints covered by platforms at two representative near-space altitudes, one at the bottom of the regime shown over Washington, DC, and the other at an altitude easily within reach of current technology depicted over Colorado Springs, Colorado. As described above, three footprint rings are shown for each platform: ground communications, signal detection, and communications links. It is important to note that most ISR sensors would not be able to image the entire footprint at any one time; those fields of view are sensor, not platform, dependent and are typically much smaller than the possible regions for imaging shown by the footprints.

While near-space platforms are high enough to provide space effects across theater-sized regions, they are much closer to their targets than their orbital cousins. Distance is critical to resolving features in images and receiving low-power signals. Optical resolution is closely related to range—double the distance, halve the resolution. Considering a point at nadir, near-space platforms are 10–20 times closer to their targets than a typical 400-kilometer LEO satellite. This distance differential implies that optics on near-space platforms can be 10–20 times smaller for similar performance, or the same size optics can get 10–20 times better resolution. Similarly for communications, the power received by a passive antenna drops off roughly as the square of the distance to the transmitter. A passive antenna on a satellite that received one watt of power from a transmitter would receive several hundred watts on a near-space platform, implying that it could

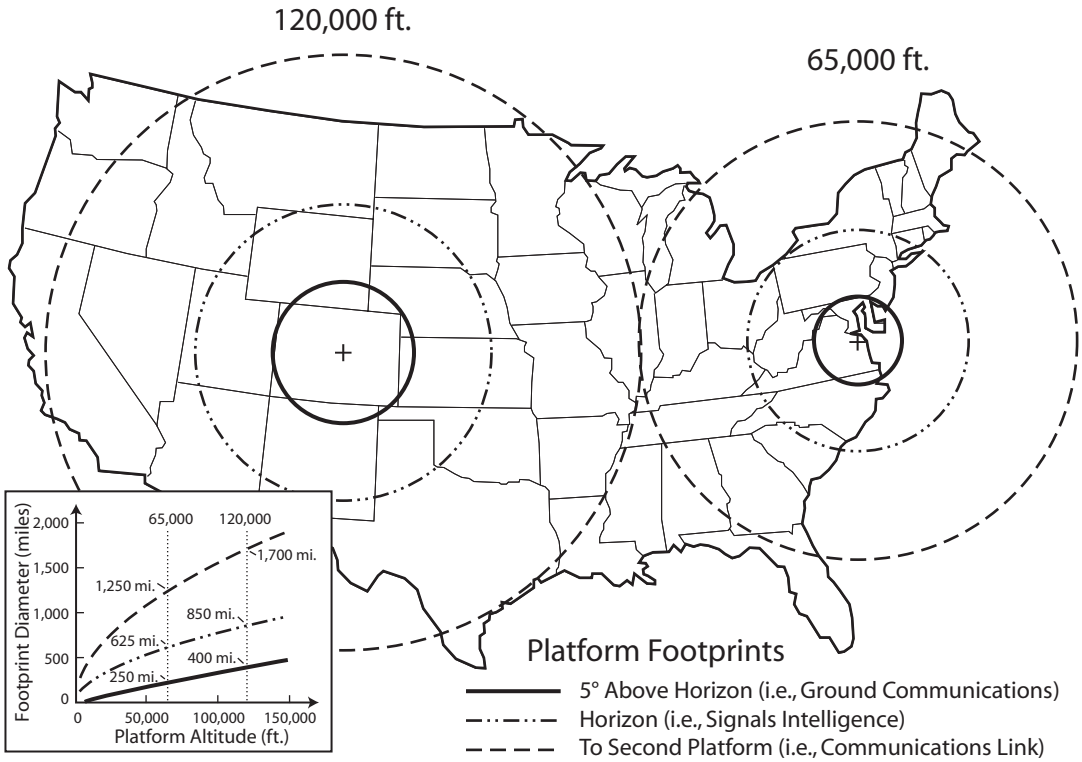


Figure 2. Footprint sizes for platforms at 65,000 and 120,000 feet for three mission restrictions

detect much weaker signals. The signal strength improvement for active systems such as radar would be about a factor of 100,000.

These examples of near-space platforms at nadir are also *best cases* for the satellites. Any off-nadir angle only increases the distance differential, increasing the near-space signal strength and resolution advantages markedly. When you realize that most communications satellites orbit not at 400 kilometers but at 35,000 kilometers above the earth, one to two *thousand* times further than near-space, it is apparent that the received power difference between the two locations is almost unimaginably large.

Though it seems counterintuitive, near-space platforms are inherently survivable. They have small radar and thermal cross sections, making them fairly invulnerable to most traditional tracking and targeting methods. They also tend to move very slowly compared to traditional airborne targets. At near-space altitudes, they are very small optical targets as well (try spotting a 747 without a contrail during daylight), showing up well only when they are brighter than the background at dawn and dusk.

Thus, the acquisition and tracking problem is very difficult even without considering what sort of weapon could possibly reach them at their operating altitudes. Manned aircraft and surface-to-air missiles (SAM) could be a threat at the lower end of near-space, but even if they were able to acquire, track, and guide on a near-space platform, their probability of kill would likely be low. Economics also discourages such an exchange, as the trade between an inexpensive, quickly replaceable near-space platform and even a relatively cheap SA-2 would rapidly become cost prohibitive.

Although the near-space advantages in footprint size, resolution, received and radiated power, cost, and survivability are significant, perhaps the most useful and unique aspect of near-space platforms is their ability to provide responsive persistence, the ability to deliver their space effects to battlefield-commander-specified locations around the clock with no gaps in coverage. The greatest persistence that a commander can currently expect from an air-breathing asset is about a day or so for a Global Hawk. In contrast, one near-space platform, currently receiving technology demonstration funding, will be able to stay on station for *six months*, and planned follow-ons are projected to stay aloft for *years*.

In all fairness, near-space platforms do have some weaknesses, the foremost being launch constraints and overflight restrictions. Large helium-filled balloons present large cross sections subject to the effects of wind and turbulence during inflation, launch, traverse of the troposphere, recovery, and deflation. Inflation times on the order of hours will probably require the construction of hangars to protect against the wind. These constraints are not showstoppers. Very large balloons (up to 300 times the volume of the Goodyear blimps) have routinely launched for years with similar constraints, and lightweight, inflatable hangars suitable for deployment are commercially available. The susceptibility of near-space vehicles to low-altitude wind means design constraints and employment concepts need to enable missions of sufficient duration to allow for launch and recovery when the weather meets system requirements and may necessitate construction of hangars for some types of platforms. Such considerations are required to ensure seamless coverage of the area of interest. Satellites face similar launch constraints, but those constraints are applied only once—during launch. UAVs and manned aircraft are also subject to similar launch-and-recovery constraints, although their limitations are less stringent than those for near-space platforms. Construction of hangars for near-space platforms is a relatively minor project when compared with construction of the launch infrastructure for other types of platforms.

The last weakness of near-space that we will discuss is overflight rights. One of the chief strengths of satellites is that by treaty they are allowed to overfly any part of the earth. Space is an international domain. Near-space assets, being kept aloft by buoyant forces, are considered air vehicles and are subject to air laws. Sovereign nations control the airspace above their borders. Thus, the deep-look capability we depend on satellites to deliver is not something that near-space can supplant. Even considering these weaknesses, near-space assets can form an additional layer of persistence between satellites and air-breathers, complementing both and making the combination of systems more survivable, capable, and redundant by their presence. They accomplish this by

- staying and staring for much longer than any envisioned airborne asset could ever hope because they have on-station times proposed to be on the order of months or years;
- getting their lift from buoyancy, not from fuel;
- moving slowly enough and at such high altitudes that overcoming drag requires a minimal draw on their power supplies;
- having large footprints that are not offset by the extremely fast orbital speeds and short pass times of satellites;
- improving upon the long-term persistence traditionally provided by satellites while providing the on-call responsiveness of airborne assets; and
- being on-station when and where a battlefield commander needs them.

Near-space assets provide the answer to the needs for organic persistence so poignantly stated by the coalition commanders of recent conflicts.

Technological Enablers and Near-Space Platforms

Until very recently, the distinction of space as a set of effects instead of as a medium was

irrelevant because satellites *were* the only platforms that could deliver space effects. However, a convergence of several technologies has changed the capabilities landscape, now making this distinction an important one. Evolutionary advances in several disparate disciplines have led to a revolutionary advance in capability. Some technologies contributing to this revolution are power supplies including thin, lightweight solar cells, small, efficient fuel cells, and high-energy-density batteries; the extreme miniaturization of electronics and exponential increase in computing power, enabling extremely capable, semi-intelligent sensors in very small, lightweight packages; and very lightweight, strong, and flexible materials that can resist degradation under strong ultraviolet illumination and are relatively impermeable to helium or hydrogen.

Taken alone, the above technologies, in general, are progressing at normal evolutionary rates. There have been few, if any, large and unusually rapid increases in capability in any of the fields. However, when those technologies are combined into a system called a *near-space platform*, the convergence of the technological advances allows a revolutionary, transformational increase in capability. It is the advent of these near-space platforms that requires a reevaluation of the concept of space as it applies to the war fighter from a platform/medium point of view to a mind-set of effects.

A near-space platform is designed to be a sort of "truck." Just as an 18-wheeler's cargo type is unimportant as long as it meets specified weight and volume requirements, a near-space platform's payload type is unimportant as long as the payload mass and power requirements are within specified ranges. Due to the inherent payload flexibility, the following discussion of near-space platforms will not generally include specific payloads. Instead we will describe the two basic types of near-space platforms currently being investigated for military use—free floaters and maneuvering vehicles.

Free floaters are basically the simple weather balloons many people imagine when they think of lighter-than-air. Very inexpensive, they are very straightforward to construct and launch, but lack the station-keeping capabilities of their more complex brethren. Once launched, they are at the mercy of the existing winds. These balloons can take tens to thousands of pounds to over 100,000 feet, but more typical payloads are in the range of tens of pounds. Free-floater systems have already demonstrated commercial viability and military utility as communications platforms. The Air Force Space Battlelab's Combat SkySat program is an example of a free-floater system currently in use.

Other than the continual constellation replenishment necessary to ensure persistent coverage, the biggest drawback to most military free-floater concepts would seem to be that their payloads generally cannot be recovered. The best that could be hoped for was to use a parachute or a short-range paraglider-recovery system to get a payload back. Innovative balloonists have devised a way around this free-floater limitation. By encasing the payload in a high-performance, autonomous glider, we can safely recover and reuse expensive or sensitive payloads. The payload is sent aloft just as it would have been on a conventional free-floating system. However, instead of destroying the payload as it drifts out of theater, as the balloon approaches the maximum range of the glider, the glider is cut loose from the balloon. The payload then autonomously glides back from hundreds of kilometers away, staying aloft for several hours before landing safely on relatively small, unprepared surfaces. Once safely back on the ground, the payload and glider can be quickly reattached to another balloon and floated again. Only the very cheap balloon part of the system is lost on each mission. The Talon TOPPER project, part of the Air Force's Tactical Exploitation of National Capabilities (TENCAP) program, is a concrete example of this concept.

We see free floaters as useful primarily for missions where a horizon field of regard is useful, missions such as communications, moving-target detection, and signals interception where only a line of sight to the signal source is required. With a horizon-sized footprint, highly accurate payload steering is not a critical ability. Free floaters are much less use-

ful for missions requiring precise navigation such as overhead imagery.

As we designed the concept, constellation replenishment is only a stopgap measure on the road to the true promise of near-space. While there will still be niche missions for free floaters in the future, true near-space effectiveness will soon rely on maneuvering vehicles that can fly to and station-keep over specified points. Such platforms are the functional cross between satellites and airborne platforms, providing the large footprint and long mission durations commonly associated with satellites and the responsiveness of a tactically controlled UAV. These vehicles will use a variety of schemes for propulsion, including conventional propellers and unconventional buoyancy-modification schemes that allow vehicles to propel themselves by porpoising through the air at about 30 to 50 knots, enabling them to overcome all but the most unusual near-space winds. No integrated maneuvering vehicle has yet been flown in near-space. However, according to the military's ballooning experts at the Air Force Research Laboratories, the reason for this problem has been a lack of sustained, significant funding required to start such a project rather than an insurmountable technical challenge.

Several programs are currently in the works. The Navy has a lower-altitude pathfinder flying and has established a significant funding line for its near-space follow-on. The Army expects to fly a larger-scale demonstration vehicle in 2007. Many other maneuvering-vehicle concepts are on the drawing board, being funded by numerous government agencies and the civilian sector. Maneuvering vehicles do not require the continual replenishment of free floaters to provide persistence. Their payloads are large enough to be militarily useful, and they can be recovered for repair and reuse. Maneuvering vehicles are the revolutionary technology primarily behind the paradigm shift to effects-based space. Figure 3 shows some current concepts.

Space Effects in Layers

Again, we do not advocate eliminating satellites or UAVs. However, in many circumstances near-space assets are the better choice for providing tactical/operational communications and ISR space effects for a number of reasons. When cost is the concern, near-space has no peer. Their inherent simplicity, recoverability, relative lack of requirement for complex infrastructure, and lack of space-hardening requirements all contribute to this strong advantage for near-space assets. Requiring only helium for lift, near-space platforms do not require expensive space launch to reach altitude. If the payloads they carry malfunction, they can be brought back down and repaired. Should they become obsolete, they can be easily replaced. Additionally, the infrastructure cost savings involved with near-space are huge. Near-space assets require extremely minimal launch infrastructure. Compare the cost of a simple tie-down and an empty field or an inflatable hangar to building a space-launch complex or even to building a hard-surface

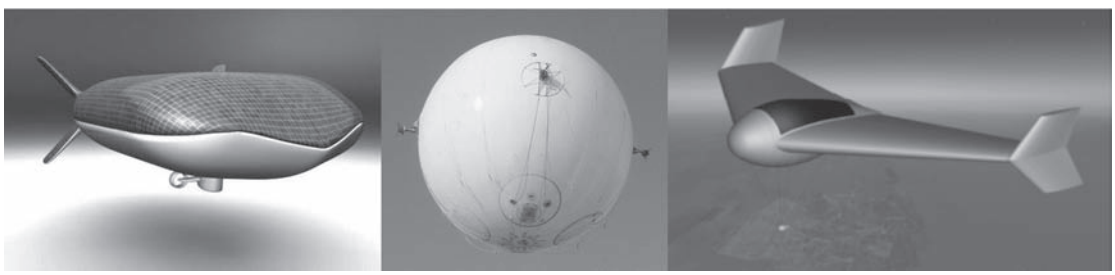


Figure 3. Three proposed near-space maneuvering vehicles. *Left to right*: GlobeTel's Sanswire, Techsphere Systems' AeroSphere, and the New Mexico State University Physical Sciences Laboratory's Advanced High-Altitude Aerobody (AHAB).

runway. The low price of near-space assets enables operational commanders to own and control fleets of them, for the price of a single national asset.

The space effects needed at the tactical and operational levels of war are persistent and responsive communications and ISR, both of which enable command and control. Orbital mechanics prohibit staring-type persistence by individual satellites in any orbit except in the distant (and expensive-to-reach) geostationary belt. Fuel considerations limit the loiter of air-breathing assets to at most a few days. Conversely, many near-space assets are specifically designed to have the ability to stay and stare for months at a time. Near-space's forte will be persistence.

Responsiveness is another self-evident need for commanders. Unforeseen requirements for imagery or communications arise constantly as a result of friction and the fog of war (ask Flaminius). Once on orbit, satellites are all but unresponsive. It takes an enormous amount of energy to change the orbit of a satellite. Satellites are also nonresponsive to launch taskings.

Air breathers, both manned and unmanned, are extremely responsive. They can be launched in minutes to hours, and once on station they can be redirected at will. Near-space platforms are also extremely responsive compared to satellites and almost as responsive as air breathers to launch and redirect. In general, near-space maneuvering vehicles require about a minute per 1,000 feet to ascend, so it takes about two hours for them to be on station at 120,000 feet. They also cruise more slowly than most air breathers, so getting to their assigned stations will take longer. However, once there they can stay for a very long time. Operational risk is substantially reduced because of the single launch-and-recovery cycle that produces months of duration on station. The stay-and-stare capability, wider field of view, and near-UAV-quality resolution provided by near-space assets could easily enable much more effective use of high-demand UAV assets by acting as cuing mechanisms. They can multiply the asset-limited UAV force by sending them only where their additional capabilities for enhanced resolution and force application are needed.

So, if satellites are so expensive and so nonresponsive and if they are physically unable to provide persistence, why, then, do we buy them at all? The answer today is the same as it has been since the 1950s—freedom of overflight. The importance of freedom of overflight cannot be overemphasized as a positive aspect of orbital operations. Satellites are the only legal means by which overhead ISR can be performed deep inside the territory of sovereign nations during peacetime. This is of paramount importance, as it enables many C4ISR effects that no other platform can perform. However, once war is declared or hostilities commence, near-space becomes the clear choice to achieve the space effects required for many operational and tactical missions. During hostilities, airspace sovereignty over enemy territory is no longer a consideration—near-space assets can operate above the same locations that air breathers can, subject to similar enemy threats. Near-space assets can then provide organic C4ISR. UAVs provide exactly this sort of local control, but the footprint of a UAV can be much smaller than that of a higher-flying near-space asset, and the near-space platform has the persistence advantage. The following table provides a comparison:

Relative strengths of satellites, near-space platforms, and air-breathing assets

	Satellites	Near-Space Platforms	Air Breathers
Cost		✓	
Persistence		✓	
Responsiveness		✓	✓
Footprint	✓	✓	
Resolution		✓	✓
Overflight	✓		

When one looks at the desired tactical and operational space effects, it is evident that there are large niches where near-space assets perform much better than orbital and air-breathing assets. When one understands that it is *effects* that matter on the battlefield instead

of the platform or medium from which the effects are delivered, near-space makes much more sense for many applications. There are also missions that satellites do extremely well, and for which near-space is not competitive. The point is that a layered approach whose goal is to enable space effects in the most economical, effective way will direct the acquisition of the appropriate platform using the appropriate medium, turning the current acquisitions methodology of medium-then-platform-then-effect on its head.

In conclusion, operationally responsive space really means operationally responsive space effects. Near-space does indeed seem to be the obvious solution to that problem. It can provide many of those effects more responsively and more persistently than space itself. The shift in mind-set to this concept is of such a magnitude that it will require a substantial rewrite of current military space doctrine. It may also require a reorganization of Air Force and Department of Defense force structure to most efficiently realize the benefits of centralized, seamless effects-based space. Near-space is the catalyst for these significant changes. The paradigm shift must occur. The time for near-space is definitely now. ❑

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