

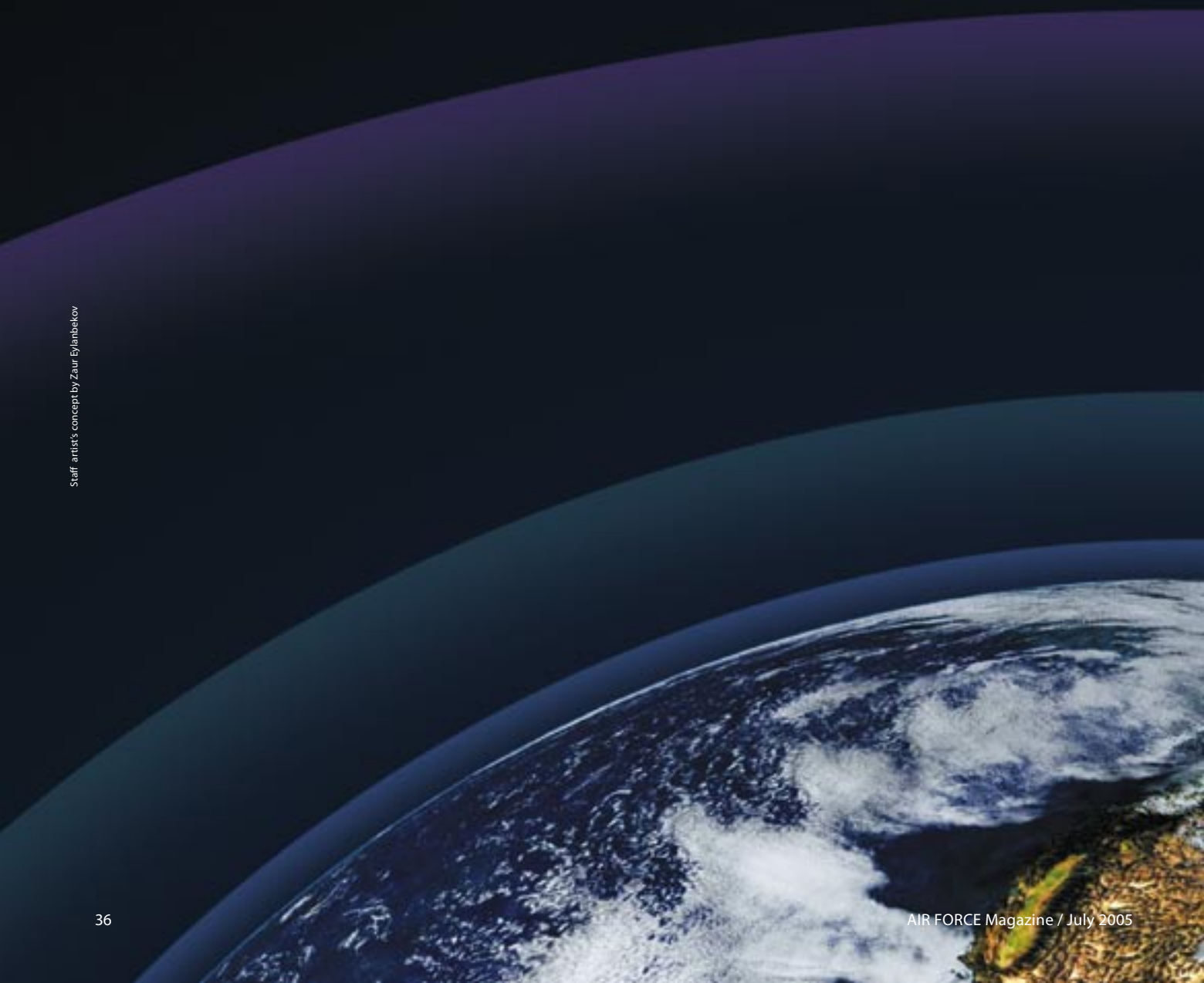


At present, this region is a “dead zone,” where nothing flies. The Air Force thinks that will change.

# *Near-Space*

By Hampton Stephens

Staff artist's concept by Zaur Eylanbekov



**T**he Air Force's operating domain—frequently called the “vertical dimension”—traditionally has been defined as that area ranging from the surface of the Earth to geosynchronous spacecraft orbits 22,000 miles up. A large slice of that domain has been ignored—until now, that is.

The place in question is the region sandwiched between an altitude of about 12 miles (close to the internationally accepted upper limit of controlled airspace) and 62 miles (loosely defined as the lower limit of space).

At present, this region is a “no man's land.” Air is too thin to support flight by most operational military aircraft, and yet gravity is too strong for a satellite to sustain itself in orbit. As a result, very little flies there.

This region is called “near-space.” Air Force officials believe it could prove to

be a key operating area. Its exploitation constitutes part of Joint Warfighting Space, a key initiative launched by Gen. John P. Jumper, USAF Chief of Staff.

Lighter-than-air vehicles operating there could quickly and inexpensively provide the capabilities that troops and commanders demand.

Enhanced communications systems, network relays, and intelligence-surveillance-reconnaissance capabilities could all use the near-space realm to quickly meet battlefield needs.

Near-space platforms carrying critical systems into the far reaches of the atmosphere could include balloons, airships, or anything else that is “persistent, cost-effective, survivable, and responsive,” said Gen. Lance W. Lord, commander of Air Force Space Command, at the Air Force Association's February Air Warfare Symposium.

A little over two years ago, Jumper asked Space Command to explore ways to provide tailored, tactical-level space effects to combat forces.

He saw the potential for near-space

platforms to provide some of the same capabilities as space-based platforms, only for much less money and with greater flexibility. Air Force leaders tout the exploitation of near-space as an ideal example of “effects-based” thinking.

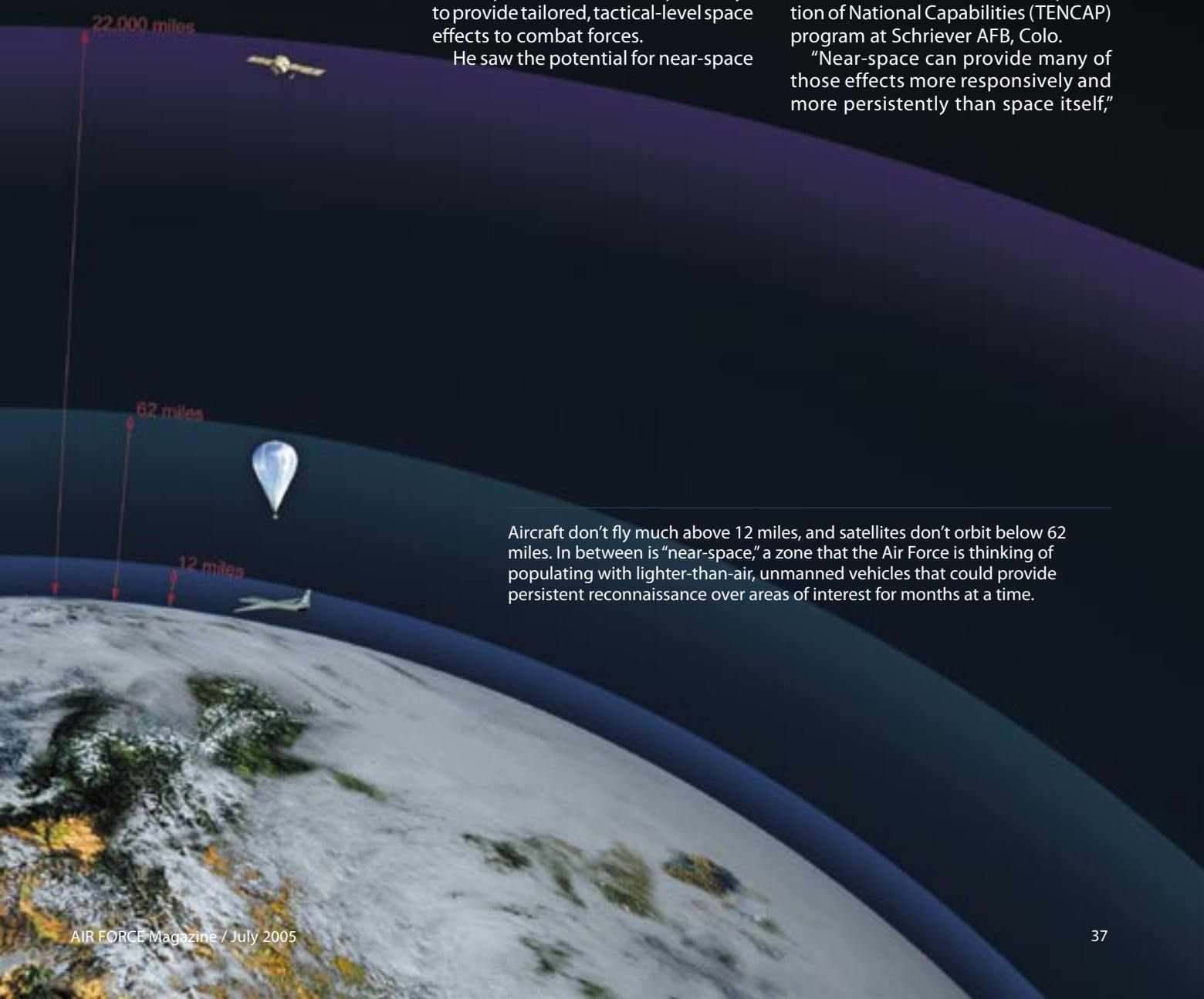
#### Seeing New Promise

Originally, the JWS initiative was focused on finding faster and cheaper ways to launch platforms into orbit. However, soon after Jumper introduced the idea, officials began to see promise in the neglected near-space area.

Satellites ensure access but are expensive and not very responsive. Air-breathing intelligence-surveillance-reconnaissance aircraft are perpetually overtaxed and could be denied access over hostile territory.

Near-space, however, opens up an entirely new realm of possibilities, said Lt. Col. Edward B. Tomme, deputy director of AFSPC's Tactical Exploitation of National Capabilities (TENCAP) program at Schriever AFB, Colo.

“Near-space can provide many of those effects more responsively and more persistently than space itself,”



Aircraft don't fly much above 12 miles, and satellites don't orbit below 62 miles. In between is “near-space,” a zone that the Air Force is thinking of populating with lighter-than-air, unmanned vehicles that could provide persistent reconnaissance over areas of interest for months at a time.



Lockheed Martin photo

The U-2, with many upgrades over the years, fills the niche of responsive, high-altitude reconnaissance. However, missions can't last much longer than 10 hours. Near-space vehicles could "stare" unblinkingly at an area for months at a time.

Tomme noted in a paper released earlier this year. Jumper himself said last December that Operation Iraqi Freedom has highlighted the need for persistent ISR capabilities. (See "Aerospace World: The Case for 'Near-Space,'" February, p. 15.)

If the Air Force can build a near-space vehicle able to hover over one point, at an altitude of about 23 miles, it could remain on station for months—far longer than an unmanned aerial vehicle and a period approaching the mission duration of certain satellites. This would be an inexpensive substitute "for a low orbiting satellite constellation that would probably have 40 or 50 satellites," Jumper said.

Alternately, a geostationary near-space system could direct coverage, so that when satellites "come over the horizon they know exactly what to look at," he said. This, added the Chief, could increase the efficiency of highly expensive strategic reconnaissance systems "several hundredfold."

Dirigibles and balloons are not terribly exciting, Jumper said, and are neither airplanes nor spacecraft. He noted that this explains, in part, why near-space has been neglected in the past. In recent remarks to the Heritage Foundation in Washington, D.C., Jumper explained that, in the near-space area, "nobody's interested. Why? Because we're platform-centric."

#### Not Cool

Aerostats and weather balloons that operate in the near-space realm "tend to

be these lighter-than-air things that are not very appealing," Jumper said. "You never go to an air show to go watch a balloon performance. They don't put on a very good acrobatic show and it's just not very cool."

The "shift in mind-set" that it will take to make full use of near-space is "of such a magnitude that it will require a substantial rewrite of current military space doctrine," Tomme contended.

Air Force Space Battlelab officials who explore possible military applications for "off-the-shelf" technology have taken note of the growing use of high-altitude balloons in the commercial sector, said battlelab commander Col. Patrick P. Rhodes. For example, Chandler, Ariz.-based Space Data Corp. uses high-altitude balloons to transmit data gathered from remote oil platforms throughout the Southwest.

The Space Battlelab sponsored an industry forum to explore such commercial technologies and discovered near-space was a fertile research area. "It was surprising to us how many folks were out there working on near-space capabilities," Rhodes said.

Putting a platform in near-space is easier and much less expensive than launching a system into orbit. Therefore, near-space systems will probably provide responsive capabilities to warfighters much sooner than orbital platforms, said Lt. Gen. Daniel P. Leaf, AFSPC vice commander.

While USAF develops responsive orbital capabilities, near-space is "the

focus that's most likely to bear near-term fruit," Leaf said. "That's because when we talk about orbital space capabilities as part of JWS, there's more development required."

The Space Battlelab is now conducting technology demonstrations. According to its charter, the battlelab must focus on capabilities that can be fielded within 18 months, so the near-space demonstrations that began late last year have used commercial technologies that require minimal modifications.

Tomme noted that officials already see near-space as a low-threat, high-payoff environment. Military near-space vehicles would operate above the weather, be inherently stealthy, and fly above the range of nearly all threats. In terms of payoff, the vehicles would be 20 times closer to the Earth than low Earth orbit (LEO) satellites, offering large coverage areas.

So far, demonstrations have explored how balloons floating above a battlefield could be used to improve tactical communications.

By attaching off-the-shelf Thales PRC-148 radios to balloons already developed by Space Data, battlelab officials have discovered that the range of line-of-sight radio communications can be significantly extended.

In March, the battlelab demonstrated how such a setup could dramatically improve close air support operations. The platform used in the demonstration was a "beyond-line-of-sight radio repeater" that has been dubbed Combat SkySat.

#### Predictable Flight

Combat SkySat consists of two linked PRC-148s—radios used by many ground troops for tactical communications—floated on Space Data's balloon. In a real sense, this huge, helium-filled latex balloon is no more high-tech than "the balloons you would get at a birthday party," Rhodes said. But Space Data technology allows the balloon to fly in a predictable flight path.

The company's command and control technology uses gas venting and ballasting to control the balloon's altitude, so that its flight path can be optimized based on wind patterns in the atmosphere. The balloon operates between 65,000 and 95,000 feet.

A "repeater" balloon flying over the battlefield can relay line-of-sight broadcasts from radios on the ground and in the air. In 12 flights conducted near Space Data headquarters, the Space

Battlelab successfully extended the range of line-of-sight radio communications from about 10 miles to more than 400 miles, Rhodes said.

The March demonstration employed members of a tactical air control party on the ground and an F-16, A-10, and E-8 Joint STARS radar aircraft in the sky to explore how such extended-range communications could improve close air support.

When a forward air controller on the ground is directing an air attack, he must make radio contact with the pilot before the attack occurs to relay precise targeting coordinates. Using line-of-sight radios forces that exchange to occur when the pilot is near the target, giving the FAC and pilot very little time to work out their plan.

In recent demonstrations, Combat SkySat changed that.

With the repeater, ground controllers were able to communicate with the strike aircraft "over hundreds of miles, so that we could initiate the 'talk onto the target'" much sooner, Rhodes said.

This could vastly improve CAS operations, according to Rhodes, because giving FACs and pilots more time to communicate makes dynamic retasking and other targeting innovations possible. "We think this near-space beyond-line-of-sight capability is a relatively easy answer to some significant problems," he said.

Before USAF can economically field Combat SkySat, it must solve one significant problem: retrieval.

In the Arizona demonstrations, the

## Near-Space's Joint Applications

A Joint Warfighting Space operating concept describes ways the service will provide near-space capabilities and effects to "joint military operations conducted in support of national security objectives," according to Air Force Space Command's JWS division.

Though AFSPC leads the operational and budget planning for near-space, the effects it provides will potentially benefit all areas of Air Force operations. The other major commands, notably Air Combat Command and Air Force Materiel Command, are helping to integrate near-space into the service's missions. "While we're leading the effort, at General Jumper's direction, we're not doing it in an exclusionary manner at all," said Lt. Gen. Daniel P. Leaf, AFSPC vice commander.

As the name JWS indicates, near-space will touch the missions of each service. For example, the Air Force Space Battlelab sought the Army's input when developing a close air support demonstration.

The Navy has been the lead service for lighter-than-air vehicles since the airship was invented, said battlelab commander Col. Patrick P. Rhodes. Though the Navy concentrates on platforms that operate at lower altitude than near-space, he said there is a lot of potential for the Air Force to learn from them.

Rhodes has entered into a "gentlemen's agreement" with his counterparts at the Army Space and Missile Defense Command and the Naval Air Systems Command to establish a "near-space council" to share knowledge on demonstrations and capabilities.

Meanwhile, Air Force officials, although cautious, are keeping an open mind about how they can use near-space. While communications capabilities are the first area of exploration, what can be floated in the new frontier between 65,000 feet and the bottom of outer space is only constrained by technology. "We don't want to limit our horizons too much at the outset," Leaf said.

Like aircraft, near-space vehicles may be developed in countless forms to serve innumerable functions. "You're going to see a range of systems that become available," said Maj. Steve Staats, deputy division chief for demonstrations at the battlelab. "The idea is to really provide an integrated capability, not focusing on the systems ... but [on] what is the effect you need."

balloon easily could be retrieved no matter where it landed; it was always overflying friendly territory. Similarly, when Space Data first began providing near-space communications services to the US oil industry, the company found

an elegantly simple solution to the retrieval problem: Space Data promised a case of beer to anyone who found and returned one of their balloons. (The company now uses cash awards.)

In combat, however, there is no guarantee that a balloon will not land behind enemy lines.

This problem can be attacked in two ways, Rhodes said. Either near-space payloads can be engineered to be disposable, or a return system can be devised.

TENCAP is working on just such a round-trip system.

TENCAP's "Talon TOPPER" concept will use a glider constructed from "very high-tech polymers" to return balloons to designated locations, Rhodes said. Now being developed by a contractor in Oregon, Talon TOPPER will be demonstrated this fall. The idea is to use a "plug-and-play" cargo bay that can carry a variety of payloads and then return safely, using GPS for guidance.

### Unclear Path

Despite all of this development work, when the first near-space capabilities will be fielded remains unclear. Air

Artist's concept by Erik Simonsen



High-resolution satellite imagery demands low orbit. However, low orbit means short dwell times over the reconnaissance target. Near-space systems could solve the problem, providing sustained coverage of enemy forces.

Force Space Command's JWS division is planning a two-week in-theater demonstration of some version of Combat SkySat, probably equipped with the Talon TOPPER return system, according to Rhodes.

Although the enthusiasm for its potential is palpable among senior leaders, officials are cautious about promising the moon. "We are looking before we leap," Leaf said, cautioning that the service has a lot to learn about operating in near-space. Tomme similarly said near-space may have been "oversold" and the Air Force is still validating concepts to reduce development risk.

To hasten that learning process, Lord tapped the Air Force Research Laboratory to lead an in-depth study of the promise of near-space. The 90-day study, completed in May, used a number of integrated product teams to examine aspects of near-space technology and develop preliminary concepts of operation.

The study looked at "potential CONOPS for a variety of near-space carrier/payload combinations, including small balloons, medium balloons, lightweight UAVs, and large airships," according to a JWS division official. Study results will be briefed to senior Air Force leaders this summer.

The AFRL study is important because the technical challenges posed by near-space are new to the Air Force. Near-space vehicles must be able to withstand significant ultraviolet radiation, harsh weather, and other tough environmental conditions.

The physics of near-space flight are also unique. For example, the carrying capacity of balloons depends partly on their size.

"The physics of volumetrics and the diminishing return as you increase payload capability and increase altitude are pretty challenging," Leaf explained, after cautioning that he was a political science major not a physicist. Increasing payload or time on station is not simply a matter of making a balloon bigger, he said. "It's a lot more complex than that."

If the Air Force wants near-space vehicles that can do more than just drift with the wind, which they undoubtedly will, other technical challenges will have to be overcome.

Leaf said there is a "divergence" among technical experts about the difficulty of "station keeping" in near-space. Industry is working on ways to get balloons and airships to stay put above a particular spot on the Earth—which

## Platform Options Abound

Air Force Space Command has a wide range of service and contractor options to investigate as it defines exactly what it needs in its near-space vehicles.

For starters, the Combat SkySat experimental communications relay system will be evaluated during the 2006 Joint Expeditionary Force Experiment. The platform is well-suited to the homeland security mission-based focus of that event, according to Air Force Space Battlelab officials.

"The homeland defense agencies are really interested" in near-space technology, said Lt. Col. Rich Lane, the battlelab's division chief for demonstrations. "You could immediately put [something like Combat SkySat] up in Arizona and provide communications relay down there to the Border Patrol." This would be of particular interest because the Border Patrol operates in sparsely populated regions where cellular phone towers are scarce.

Another AFSPC program, called Talon SHU, is aimed at developing software to model the weather in near-space, in anticipation of the day when near-space vehicles are in regular use.

Lockheed Martin, meanwhile, has been working for several years on the Army/Missile Defense Agency High-Altitude Airship advanced concept technology demonstration, and Boeing has proposed several near-space solutions, according to AFSPC officials.

Sanswire, a subsidiary of Globetel Communications Corp., is another pioneer of near-space technology in the commercial world.

Finally, the Johns Hopkins Applied Physics Laboratory is one among several academic research organizations that are exploring near-space technology. The Johns Hopkins APL is working on air- and missile-launched near-space balloons and high-altitude tethered air vehicles, according to AFSPC.

would obviate the need to launch a continuous series of balloons to maintain persistent communications or ISR coverage of an area.

### How Effective?

So while there certainly will be innovative approaches to such challenges as station keeping, "our question remains, how effective will they be—and what does that mean in terms of the operational utility of near-space systems?" Leaf said.

Rhodes believes that simple near-space systems that provide niche tactical capabilities can be developed very quickly, but more complex systems will take longer. "When you start talking about long-loiter, strategic kinds of station-keeping vehicles, I think we're a ways away," he said.

To work out the technical complexities of near-space, the AFRL-led study likely will lead to "additional demonstrations ... but, more importantly, into continuing budget commitment," Leaf said.

Space Command is eyeing the Fiscal 2008 budget for the first significant commitment of near-space funding. So far, most of the money the Air Force has spent on near-space has come out of the Air Force Space Battlelab budget.

By mid-May, the battlelab had not completed a budgetary assessment for Fiscal 2006, but the Air Force's 2006 unfunded priority list included \$10.4 million for JWS, much of which would go to near-space, if appropriated.

Although a major appeal of operating in near-space is the potential to get more bang for the buck, compared with operating in orbit, each medium has cost advantages and disadvantages. Near-space systems will not incur the cost of "booster integration or on-orbit checkout," Leaf pointed out, but the service must figure out how to recover near-space payloads to reap their full cost benefits.

Near-space platforms will be less durable than satellites that can stay in orbit for 30 years or more but also more flexible. In the end, nothing in the Air Force budget is immune from spending constraints. "We have to recognize that there are very challenging budget pressures that limit our, for want of a better word, discretionary funding in these endeavors," Leaf said. "Our desire for progress will be moderated by the availability of funds."

While the future remains uncertain, the Air Force is planning for near-space capabilities to be part of its force. n

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