

The Air Force Scientific Advisory Board surveys the prospects of space as a theater of operations.

The Arena of

By Peter Grier

EARLY in the twenty-first century, space will probably become an important theater of military operations—as critical as land, sea, and the atmosphere—according to a trailblazing new Air Force technological study. US forces must be prepared to do more than use space simply as a medium for communications and intelligence. The US should plan to exploit space as a battle arena, as the high ground to be controlled, from which and in which it will fight.

The Air Force, the nation's lead service for space operations, thus needs to begin developing an arsenal of appropriate weapons now, concludes just-released volumes of the "New World Vistas" report. Among the possibilities advanced by the Air Force Scientific Advisory Board are specialized space "mines" that stealthily destroy the sensors of enemy satellites and orbiting metal rods capable of plunging at hypersonic speed into buried bunkers on Earth.

Air Force personnel might also have to be ready to blast into space themselves, says the report. Maintenance and upgrades of expensive military space systems could require a human presence.

"As the race of technology unquestionably establishes space as a future theater of war, it is important that we build an architectural foundation for space that draws on the principles of war," concludes the "Space Applications Volume" of the Vistas study.

"New World Vistas: Air and Space Power for the 21st Century" was a major USAF Scientific Advisory Board effort commissioned by Sec-

retary of the Air Force Sheila E. Widnall in November 1994 [see "New World Vistas," March 1996, p. 20]. It explored the concept of what the future might hold and produced an expectation of change on an epic scale. Its summary volume was released last January. Supporting documents detailing the work of the study's task forces took longer to wend their way through the declassification process and were finally made public in May.

Lighting the Path

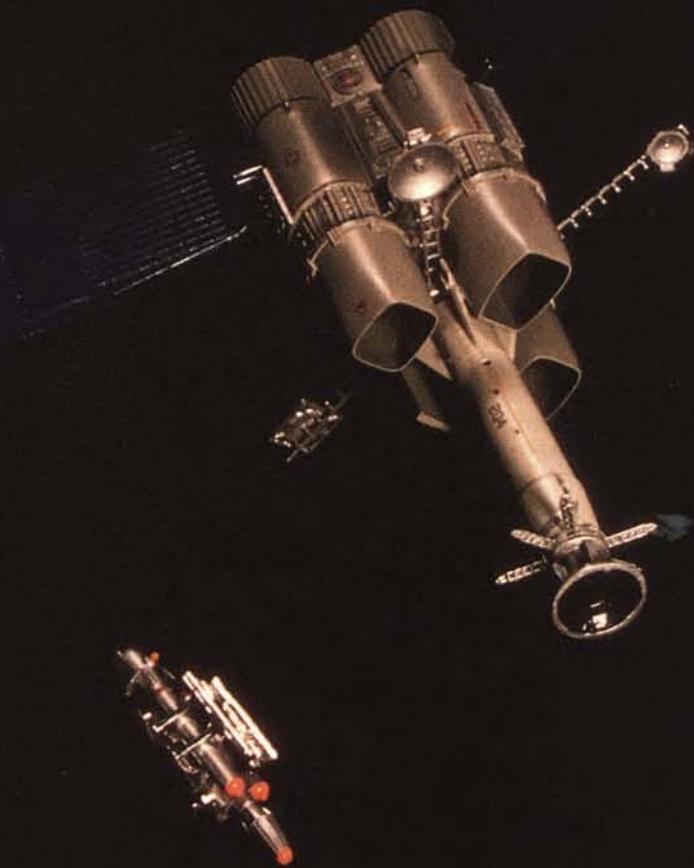
The effort, which produced a 2,000-page compendium of analysis, reporting, and conjecture, was consciously modeled on "Toward New Horizons," the seminal 1945 effort that predicted many of the systems and technologies that have appeared in the Air Force in the past fifty years. Top service officials hope the Vistas study will similarly light the way for the Air Force at a time of ultrarapid technological innovation.

The Advisory Board looked at everything from Air Force munitions to logistics, but space operations was a principal focus. Today, military doctrine for the use of space systems is at the same stage that aviation strategies and tactics were at the beginning of World War I, according to participants in the New World Vistas study. That means space is seen primarily as a medium for scouts or messengers—not warfighters.

Today's rapid technological developments are likely to change all that. No longer will the US, despite its massive investment in satellite

In the days of World War I, the airplane was used mainly for reconnaissance and communications, much as satellites are used today. In the future, predicts a landmark USAF study, space will be a battle arena to be dominated.

Space



and launch systems, be unchallenged beyond the Earth's atmosphere. Fast development of commercial and foreign satellite systems means that access to space will be widespread, said the study's authors, and, inevitably, adversaries of the US will use space for their own military purposes.

The first step for the US in adapting to this new situation, contends the Vistas study, may be to cease thinking of space solely as a medium that provides support to more important mission areas and to view it instead as a place to be dominated, as the US now plans to dominate terrestrial areas of conflict.

If nothing else, the importance of the information that now flows through space systems to both the US and its allies means that the US may need the muscle to protect freedom of cyberspace navigation, much as national naval fleets through the centuries have enforced freedom of navigation on the high seas.

The new uses to which information technology will be put can only make space control more crucial than it is now. Today's Global Positioning System (GPS) data and satellite communications pipes will be supplemented by such future capabilities as spacebased submarine detection, instant delivery of updated maps to patrol leaders, and satellite guidance of precision munitions accurate to within a centimeter of the target.

Broadly defined, information warfare may be more effective in collapsing the enemy than more traditional modes of military force would be, claims the Vistas report. The point of the New Vistas space study is that the Air Force needs to focus on the warfare side of this equation as well as the information side.

The authors say Americans should consider the likely situation in thirty years: US military and commercial satellites, combined with ground stations and launch sites, will constitute perhaps the highest-value target an adversary could destroy. Conversely, adversaries may possess their own space assets—which the US surely would want to disrupt, degrade, or destroy.

"Increasingly, space control broadly defined as both physical control and information control will be a prerequisite for effective land, sea,

and air control," says the Vistas space panel.

Space Weapons

Projecting force from space toward Earth is a politically delicate subject, as Vistas authors acknowledge. Nevertheless, it could well be a road the US needs to take in coming years, as declining launch costs might allow some other nation to do it first.

"Satellites [provide] a presence over battle areas that is difficult to deny, . . . so that force application using them could have a marked strategic as well as tactical effectiveness on the conduct and outcome of conflicts," say Vistas space application authors. "It is equivalent to artillery and strike support with infinite range and moving at 25,000 mph."

The use of orbiting rods of depleted uranium might be one force-projection approach. Based on developments pioneered by the old Strategic Defense Initiative Organization, these tiny weapons would be equipped with small boost rockets and GPS guidance electronics. Ordered by ground controllers to plunge from orbit, they would travel at hypersonic velocity as they neared Earth. Their speed would be such that they could penetrate hundreds of feet into the earth, overcoming all attempts to harden underground command bunkers. They might even be effective against high-value airborne targets, such as Airborne Warning and Control System aircraft.

"This ability to call down and accurately deliver mass from orbit [to] surface or airborne targets with complete surprise amounts to munitions with ultimate stealth, for which there is little effective passive defense," concludes a Vistas force-projection report.

Electromagnetic radiation weapons might be another technology that is close to coming into its own. Development of large thin-film antennas could enable spacecraft to project narrow beams of radio frequency (RF) energy over long distances to either space or ground targets.

An RF satellite with a 100-meter-diameter antenna could theoretically produce a charge of ten million megawatts of power. From the height of geosynchronous orbit, argues the Vistas study, such a

weapon could, in essence, fry all surface electronics in an area about six miles wide.

Orbiting solar power stations—a likely commercial development over the next two decades—could well boost the power of RF satellites even further. They could also help space-based high-energy lasers attain smaller spot sizes at longer ranges, perhaps making them a practical alternative weapon.

Such physical attacks, however, might well constitute an unwanted provocation under certain political situations. More stealthy space weapons might also be needed to fill out any Air Force space-control arsenal. So-called rendezvous space weapons, for instance, are small satellites that gradually edge closer to target space assets. They might quietly spray paint onto an adversary's sensors or solar panels or nudge the craft gently to send it out of orbit. Rendezvous weapons effects might be difficult to distinguish from simple malfunctions.

"In the next decade or two, new technologies will allow the fielding of spacebased weapons of devastating effectiveness," conclude report authors.

If the US does field systems intended to control the high ground of space, defending its own systems may prove to be a big problem. Some of the weapons that could be used against satellites, such as aircraft-launched kinetic antisatellite (ASAT) interceptors, are relatively inexpensive compared with the cost of the satellites themselves. An adversary could develop a formidable space-denial capability without having to commit resources on a gargantuan scale.

Decoys might be one defensive solution. Lightweight fake satellites attached to the real thing with long tethers might be able to fool the simple ASAT weapons that will be within reach of regional US adversaries in the early decades of the next century, for example.

But it's expensive to put even relatively lightweight decoys into orbit, and thus a decoy-ASAT exchange rate can favor the attacker. As ASAT weapons become more sophisticated and able to distinguish among a number of decoys, the value of fake satellites could precipitously decline.

Furthermore, development of space

"mines" may soon be within the reach of a number of other advanced nations as well as the US.

"Mines are quite awkward to negate," notes the Vistas space applications study, as it is not clear if they would be detectable from the ground.

The technology of groundbased pulse lasers is relatively well understood. The cost and detail problems of building a large weapon might eventually be overcome by hostile nations—and laser pulses can be generated for around \$1,000 per shot, much less than the cost of deploying individual decoys.

Satellites might be made somewhat more survivable by the use of armor and maneuverability, conclude Vista authors. But the problem of protecting satellites makes clear the need for an increased reliance on distributed networks of smaller satellites.

However, right now the Air Force is not doing much to develop either defensive or offensive space-control capability, according to the Vistas report. Its space-systems authors complain of a "growing gap" between Air Force policy and the likely course of future events beyond the atmosphere.

Space Control

In the future, the US should have a spectrum of offensive systems technologies capable of dominating the heavens, according to Vistas participants. That means having the ability to disrupt an adversary's communications periodically and having actual weapons able to neutralize hostile satellites.

The Vistas panelists suggest that the simplest way to seize control of the ultimate high ground would be to target and attack the ground systems associated with space systems, such as satellite control headquarters. The advantage, they argue, would be that no elaborate new weapons or space systems would be required.

The next step up the escalator likely would be electronic jamming of an adversary's space assets. The act of "uplink jamming"—or interfering with satellites themselves via brute-

force noise or other selected wavelength interference—is an attractive option but requires large amounts of electric power. That means uplink jamming systems are likely to be large and complex. Downlink jamming—blocking ground-system reception of space transmissions—

The Vistas authors see a "growing gap" between Air Force policy and likely future events beyond the atmosphere.

might be a simpler technological task. The dedicated jamming aircraft and helicopters now used to perform conventional airborne jamming missions could be modified for use in this role.

According to the study, ASAT weapons might be a more effective, though more challenging and expensive, space-control instrument. So-called kinetic energy weapons are the current state of the art of ASATs, though they remain complex and difficult to keep ready. Current types include satellites that can be maneuvered to collide with other satellites and missiles launched from aircraft.

Directed-energy weapons able to attack space systems should also be considered, according to Vistas authors. Both RF and laser ASATs have been proven technically feasible, though target location and aiming remain difficult. Report authors

recommend development of ground-based directed-energy weapons, largely because of the difficulty of building high-output, lightweight power systems.

Finally, the Air Force might need to consider how to clear away space debris, notes the space applications study. Such an activity might be analogous to clearing sea lanes of mines or dangerous flotsam. Today, Earth is orbited by more than 150,000 pieces of debris that are large enough to damage or destroy a US space system—and the amount of such debris is likely to mushroom in years to come, when there will be hundreds or even thousands of small to medium-size satellites in orbit.

Deployment of a small, ground-based pulse laser that would shoot the stuff out of the way is one solution to the debris problem, according to the report. Studies indicate that one site using current technology might be able to clear all of today's low-altitude debris in four years. NASA is just beginning to study such an approach.

Junk Cops

Eventually, the growth in space junk, plus the increase in worldwide commercial space and military systems, will require a system capable of tracking and communicating with all active spacecraft via standard commands, predicts the study. "In essence, a space traffic control system will be needed, controlling traffic in and around high-value spacecraft, such as the space station, and in populated . . . orbits," says the report.

The Vistas study also urges USAF to consider "direct participation" of Air Force personnel in space. Current space systems are artificially divided into manned and unmanned categories, it says. In the future, even unmanned satellites may need maintenance and upgrades if they are to be cost-effective over the course of their service lifetimes.

Development of an orbit transfer vehicle able to move Air Force technicians from a launch vehicle or space station to satellites in need of repair could be a key to this capability. In fact, according to the study, the Air Force "would be remiss if it does not actively exploit the human resource where appropriate when developing future systems." ■

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