



An artist's conception of a GPS-IIRM satellite in orbit.

Defended

Space

By Rebecca Grant

The right to self-defense includes the space realm, and the US is ramping up efforts in that arena.

It's time to defend space. Or at least 73 trillion cubic miles of it.

"Historically, we designed and built our space systems to operate in an environment that was not contested," Air Force Secretary Deborah Lee James said in her address to the national Space Symposium in April. "This is no longer the case. We need to change our thinking in order to confront the threat of a possible conflict that one day could extend into space."

Challenges ahead may one day include having "warfare effects in space," James asserted.

In case anyone missed that message, Gen. John E. Hyten, head of Air Force Space Command, expanded on it in a "60 Minutes" TV appearance on April 26. "If we're threatened in space, we have the right of self-defense, and we'll make sure we can execute that right," Hyten told correspondent David Martin.

The Pentagon is adding \$5 billion in the next budget to improve command and control and real-time options for protecting America's space capabilities. For space, the new goal is self-defense.

FALSE JADE

China's multiplying space achievements are a principal reason why American military leaders are emphasizing space defense.

In 2013, China became only the third nation to land a vehicle on the moon, with its lunar rover "Jade Rabbit." But it's the steady progress in potential military space capabilities that could change international policies.

"Without question, China is mounting a serious aerospace challenge against the United States," said Deputy Secretary of Defense Robert O. Work in a June address at the RAND Corp. The Chinese "are pursuing a range of counterspace capabilities while at the same time improving their own space capabilities because they are obviously thinking that they will have to fight to maintain space superiority in the future."

China's bold moves began with a missile shot that took down one of their own satellites on Jan. 11, 2007. The incident infamously spewed more than 3,000 new pieces of debris into orbit, and led to international condemnation.

"The direct-ascent ASAT system China tested could threaten satellites in LEO [low Earth orbit].

These include US military satellites used for reconnaissance, remote sensing, surveillance, electronic surveillance, and meteorology," wrote Phillip C. Saunders and USAF Col. Charles D. Lutes in an analysis for *Joint Forces Quarterly* shortly after the event.

In 2009, People's Liberation Army Air Force Commander Gen. Xu Qiliang called militarization of space a "historic inevitability." He retracted the remark after high-level criticism, but Xu was later promoted to the higher position of vice chairman of the Central Military Committee—the first air force officer to hold the job and a sign the remark didn't really bother his superiors.

China followed up with a space launch of a similar profile in July 2014, a fact highlighted in the Pentagon's 2015 annual report on Chinese military power.

"China continues to develop a variety of capabilities designed to limit or prevent the use of space-based assets by adversaries during a crisis or conflict, including the development of directed-energy weapons and satellite jammers," concluded the report.

Even more worrying was a May 2013 launch to a peak orbit at 30,000 kilometers (18,600 miles) above the Earth's surface. The 2007 test had demonstrated capabilities in low Earth orbit. The 2013 shot "could ... have been a test of technologies with a counterspace mission in geosynchronous orbit," theorized the Pentagon in its report.

China has not acknowledged a space weapons capability. But at least one Chinese military writer said, "Destroying or capturing satellites and other sensors ... will deprive an opponent of initiative on the battlefield and [make it difficult] for them to bring their precision guided weapons into full play."

The US and China come at the space problem from different angles. "Where to the Chinese, [space] is an area that needs to be protected in times of crisis, to the US it's a place that needs to be open to prevent that crisis," USAF School of Advanced Air and Space Studies professor Everett C. Dolman told Australia's *Sydney Morning Herald*.

WARFARE EFFECTS

Of course, defending space is not just a bilateral problem. Ten nations besides the US can launch objects into orbit. "Soon every satellite in every orbit will be able to be held at risk," said USAF Lt. Gen. John W. "Jay" Raymond, then commander of 14th Air Force (Air Forces Strategic) at the Space Symposium.

For the Air Force, providing space superiority has long been a core function. Since its formation in 1982, the airmen at AFSPC "have basically developed the capabilities that fundamentally changed warfare forever. And we're not going to go back to the way we used to fight," attested Hyten, speaking in April to the Defense Writers Group in Washington, D.C. USAF space capabilities enable joint operations of every type.

What's shifting is US policy. Official statements are shaking off some of the Cold War-era prohibitions against the use of force in space. President Barack Obama in the 2015 National Security Strategy gave this warning: "We will also develop technologies and tactics to deter and defeat efforts to attack our space systems; enable indications, warning, and attributions of such attacks; and enhance the resiliency of critical US space capabilities." The new stance brings forward strong claims to self-defense.

Of course, the Outer Space Treaty signed in 1967 is still in effect. But the treaty language shows why it is now only a partial basis for future steps. When the

treaty was signed in London in January 1967, the focus of US-Soviet activity was banning military bases on the moon and dialing-down nuclear tensions.

“The moon and other celestial bodies shall be used by all states parties to the treaty exclusively for peaceful purposes,” stated the treaty. “The establishment of military bases, installations, and fortifications, the testing of any type of weapons, and the conduct of military maneuvers on celestial bodies shall be forbidden,” the treaty partners agreed. The historic treaty removed the moon from sovereignty claims, established liability for satellite owners, and opened up space for free exploration. The treaty also banned nuclear weapons in space. But it didn’t address a world where the US alone has 500 satellites in orbit, accompanied by dozens of international projects and over 23,000 known pieces of space debris.

Nearly 50 years later, it’s the rising activity in satellite orbit bands that is creating competition. A creature of its time, the treaty did not directly address issues such as space debris, much less the use of objects as weapons in Earth orbit. According to the State Department, this was a “nonarmament” treaty, like a predecessor document that banned the militarization of Antarctica. As a result, the language leaves gaps.

US officials are treading carefully. “There is not an agreed-upon code of conduct,” said James, who also appeared in Hyten’s “60 Minutes” report.

REVEALING

USAF has revealed much this year about its posture for ensuring space control. Beyond this, technologies and mission requirements point to several possible applications of power in or from space—and nearly all are likely to involve USAF.

The first challenge is to defend vital capabilities from disruption or outright attack. Job One is making the satellites and their support systems more resilient. “When it comes to GPS, the thing I worry about first is jamming,” Hyten told the Defense Writers Group. “When it comes to SATCOM, the thing I worry about first is jamming.” It’s a long-standing concern, in part because basic jamming devices are easy to acquire outside the US.

Space domain awareness is another critical step. Programs underway for several years are ready to deliver what Hyten termed an “exquisite understanding of what’s going on in all domains in space.” The goal is “give the commander of the Joint Functional Component Command for Space and the commander of Strategic Command the ability to actually do things.”

What about interfering with a satellite? The US demonstrated anti-satellite capabilities in the 1980s and again with the 2008 destruction of a satellite making an unpredictable re-entry. But there’s much more to space control.

In jamming, for instance, the US is hardening its own satellite systems against interference, but that doesn’t rule out the use of jamming as a space control tool. “We have a capability called



USAF photo by Duncan Wood

Secretary of the Air Force Deborah Lee James speaks at the annual Space Foundation symposium in Colorado Springs, Colo., in April. James makes no bones about the fact that space defense is imperative.

a countercommunications system that is built to deny an adversary the use of space communications. All I can say is it’s a capability that exists on the ground

USAF photo by Michael Stonecypher

The X-37B on the runway at Vandenberg AFB, Calif., in 2010, after its 220-day maiden voyage. The spacecraft has since logged a mission lasting 675 days.



and it does not create debris in any way,” Hyten told “60 Minutes.”

Deorbiting is another example. Old satellites are either parked or flown into the atmosphere so they burn up on re-entry. Managing satellite life cycles often includes planning for how to deorbit the satellite by nudging it slightly. Space superiority may be partly a game of maneuver. Deorbiting a satellite can bump it out of a useful orbit or send it spiraling into the atmosphere.

Deorbiting was conceived to redirect satellites into position to break up as they re-entered. Many techniques can be used—and some may have the potential to be aggressive. One way to deorbit a satellite is to use a burst of fuel such as compressed gas to change the orbit and slow it down. Another method is a tether. A long tape unfurls behind the satellite, creating electromagnetic charges from the magnetic fields surrounding Earth. The friction results in a small amount of drag. Releasing a balloon accomplishes the same task.

Not all deorbiting happens on purpose. In 2013, Ecuador launched that nation’s first satellite, a small Cubesat named Pegaso. It suffered a “lateral collision with

particles” of a 1980s Soviet S14 fuel tank at an altitude of 404 miles, somewhere over the Indian Ocean, according to the Joint Space Operations Center. It later spiraled out of control, ending its mission.

Then there is the X-37 research testbed. Since its first launch in April 2010, the X-37 orbital spaceplane has been enticing observers with its endurance and mysterious missions.

“It could be a space bomber, ... a spy plane, [or] on a mission ... to take out satellites” or deploy spy satellites, speculated London’s *Daily Mail* on June 1, 2015. The X-37B spaceplane launched for its fourth mission in May 2015. The spacecraft is just 29 feet long and has logged one mission lasting 675 days.

The mission “cannot be specified,” USAF spokesman Capt. Christopher Hoyler told Space.com. Hoyler said the X-37B was “investigating an experimental propulsion system” as part of research for reusable space vehicles. He also said USAF’s Rapid Capabilities Office would “host a number of advanced materials onboard the X-37B for the National Aeronautics and Space Administration to study the durability of various materials in the space environment.”

“It’s really for cool things,” Hyten said of the X-37 during his interview with “60 Minutes.” Right now the missions can’t be discussed in part because “we’re experimenting,” he said.

USAF also shed light on advanced capabilities affecting higher, geosynchronous orbits. Put simply, there are new kids on the block in GEO.

“I think they’ll be able to threaten every orbital regime that we operate in. Now we have to figure out how to defend those satellites, and we’re going to,” Hyten said. Specifically, Space Command has “deployed two highly maneuverable surveillance satellites to keep watch on what other countries are doing high up in geostationary orbit,” Hyten announced on the CBS show. “We want people to understand that we’re watching. There will be no surprises in GEO. ... It’s way too valuable for us to just be surprised.”

Gen. Xu Qiliang, chief of the Chinese air force, during a visit to India in 2008. Xu has said the militarization of space is inevitable, and China is moving boldly in that direction.

CHANGING ATTITUDES

Changing attitudes toward self-defense in space could extend to missile defense, too. Though it was once banned by treaty, a defensive weapon in space could become part of the missile defense kill chain.

“If the US is to get serious about defending itself from ballistic missile attacks of all ranges and scales, it will have to revive the space-based missile defense interceptor approach,” urged Michaela Dodge of the Heritage Foundation, in a *Space News* article. The 1972 Anti-Ballistic Missile (ABM) Treaty squelched development of space-based weapons to counter ballistic missiles. To the Nixon Administration the treaty was essential for homeland security and reduced the Soviet Union’s incentive to deploy more offensive nuclear ballistic missiles.

However, President George W. Bush pulled the US out of the treaty in June 2002, citing the rise of rogue threats. Ground- and sea-based missile defenses flourished, stimulated with nearly \$8 billion per year in funding.

In the early 1990s, the Global Protection Against Limited Strikes program included a space-based component. This child of “Star Wars” was an update on the Brilliant Pebbles concept, once part of the Reagan-era Strategic Defense Initiative. Approximately 1,000 small objects in low Earth orbit would be in position to kinetically attack enemy missiles in the boost phase. Attacking in this part of their flight is appealing because an early intercept might destroy the missiles before they maneuvered or deployed countermeasures. Strengthening the kill chain by destroying even a portion of missiles during the boost phase would leave fewer potential targets for the midcourse Ground-Based Interceptor and deployed terminal defenses such as Patriot and THAAD to catch.

Technical risk still raises concerns and so far, no Administration has invested in space-based missile defense, noted adjunct RAND analyst Marvin Schaffer. Presidents Reagan and George H. W. Bush supported space-based missile defense but abided by the ABM Treaty. The George W. Bush and Obama Administrations invested in sea-based and ground-based systems.

Small, rogue arsenals like those of North Korea and Iran could be effectively targeted with space-based systems. They wouldn’t replace terminal intercept, but could help guard against rogue missiles reaching their targets or overwhelming current defenses.





USAF photo by A1C Ian Dudley

Burns said at State Department talks on space exploration, a few months before his 2014 retirement.

Regional rivalries are also fueling competition. “Asia’s space arrangements are highly nationalistic, sometimes secretive, and mostly competitive,” wrote James Clay Moltz in a January 2015 piece for *The Daily Beast*. Japan in 2008 ended its ban on military activities in space—probably in direct response to China’s direct-ascent test. Also in 2008, India ramped up its space program with a lunar orbiter and new Mars programs. North Korea has attempted to put working satellites in space. Meanwhile, China formed a space consortium including Bangladesh, Thailand, and Mongolia.

Regional rivalries like these deviated from the pattern of European cooperation and US-Soviet joint missions. “The recent linkages between space and hostile forms of military nationalism could get out of hand, absent regionwide talks to defuse tensions and identify common threats in space, such as harmful orbital debris,” Moltz explained.

The good news is, the threats are still under development, “but they’re very close to fruition and we need to make sure that we’re prepared for that,” Hyten told reporters.

Whatever happens, the US will stand with its closest allies. Australia is hosting a new C-band radar assisting with tracking space debris. The US and Japan are deepening ties. Other close allies have joined coalition space operations.

According to Hyten, the JSPOC is already a coalition space operation center. “We have a Canadian chief of combat ops; we have an officer from the United Kingdom who is our chief of plans and strategy,” he told defense reporters in April. “We’re going to continue to expand” international space partnerships.

Hyten said in a speech at the Air Force Association’s Air & Space Conference last year, “The United States will employ a variety of measures to help ensure the use of space for all responsible parties.”

He continued, “Consistent with the inherent right of self-defense, [we will] deter others from interference and attack, defend our space systems, and contribute to the defense of allied space systems, and if deterrence fails, defeat efforts to attack us.”

Gen. John Hyten, head of Air Force Space Command, taping an interview with the television show “60 Minutes” at Vandenberg. Basic jamming equipment is easy to procure outside the US, so Hyten is focused on making US satellites more resilient.

China is driving threat complexity here, too. “China is working on a range of technologies to attempt to counter US and other countries’ ballistic missile defense systems, including maneuverable re-entry vehicles (MaRVs), MIRVs, decoys, chaff, jamming, and thermal shielding,” noted the 2015 Pentagon China report.

STRIKE OPTIONS?

What about directing kinetic kill vehicles or other weapons from space orbits onto terrestrial targets? Like the ICBM-riding global strike proposals, the notion of strikes—sometimes referred to as “Rods from God”—gets around issues of speed and survivability by using the formidable power of gravity.

The Air Force has clearly stated it does not have space weapons. Yet speculation continues. Storing weapons on-orbit for conducting surface strikes may have tactical advantages but it also comes with drawbacks. Weapons would have to be launched to orbit, then remain available for years. The number of weapons stored in space would be an object of debate and prices would be very high. Technical factors might limit the deterrent value of a space-based arsenal.

One popular use for a future space weapon might be a global effort to divert or break up asteroids big enough to survive re-entry and cause damage.

The European Union’s NEOshield experiment has researched ways to intercept asteroids. The best option is to intercept a space rock when it is still very far away, when a physical or

gravitational nudge can change its course slightly and steer it away from Earth.

“If we want to stop an asteroid on collision course with the Earth from hitting us, we’ll need to fire at it many years ahead of time.” So said Frank Schäfer of the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut in Freiburg, Germany, quoted in a 2013 interview with *Science Daily*.

Collisions aren’t frequent, but are devastating when they happen. A meteor over 60 feet wide blazed through the atmosphere and exploded over Chelyabinsk, Russia, in February 2013. More than 1,500 people were injured, mostly by flying broken glass, from the meteor’s shockwave.

A larger such event in Siberia in 1908 flattened and burned trees for dozens of miles. Arizona’s Meteor Crater also bears witness to the potential for impact. Scientists believe the object that hit Earth 50,000 years ago, forming the crater, was 150 feet across. It left a crater more than half a mile wide.

NOT ALONE

Threats and technologies are converging, and this is opening up the space policy debate.

“The question facing us today is whether we can muster the courage and political will to advance space exploration and ensure that cooperation continues to trump competition,” Deputy Secretary of State William J.

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