Defense One

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MISSION: *SPACE*

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CHAPTER 1

NOBODY WANTS RULES IN SPACE

AS SPACE BECOMES MORE CROWDED, THERE'S LITTLE HOPE FOR NEW INTERNATIONAL RULES TO MAKE IT SAFER.

BY PATRICK TUCKER

Debris from a crashing Chinese rocket hurtling toward Earth and a Russian projectile-shooting spy satellite are the two examples of a big problem: too few rules governing how nations behave in space. Wednesday on Capitol Hill, lawmakers pressed Biden administration officials on what the United States can do to set some hard boundaries. The answer: The United States wants norms in space, but don't expect anything legally binding anytime soon.

There are some internationally agreed upon rules for how nations can use space. The 1967 Outer Space Treaty says countries can't place weapons of mass destruction in space. But the treaty doesn't prohibit putting other weapons in space, shooting at satellites with anti-satellite rockets, or launching large objects that will come crashing back down to Earth in lots of pieces with unpredictable trajectories.

AUBREY GEMIGNANI / NASA

Rep. Jim Cooper, D-Tenn, opened the hearing by lamenting a lack of U.S. leadership in establishing rules to curb such behavior. "It seems we've given up on the idea of ropes or any punishment. But we're just going for spider webs instead. Is that the best we can do?"

Answered the State Department's Bruce Turner, "I think we're trying to make the best out of what is possible at this given moment in time." That does not "exclude the possibility of legally binding treaties down the road, but that's not where we are, given the kinds of competition posed by Russia and China."

The United States instead will reach out to like-minded countries to establish non-legally binding norms, said Turner, who leads the department's Bureau of Arms Control, Verification and Compliance. That in turn could "create peer pressure" on countries like China and Russia to align with what other countries are doing. "And maybe over time develop more far-reaching measures," he said.

All of that suggests the United States and other nations are far away from establishing a new treaty on space behavior. During his testimony yesterday, Turner brought up the downsides of such agreements.

"The advantage of a treaty is that it's a legal obligation...so you could argue a violation is more straightforward. Except if you've ever worked with a lawyer, you know one of the things you get into is these very difficult and complicated interpretations of what the treaty actually says."

He said the lack of a legally binding mechanism to punish bad behavior in space "does not mean you can't call someone out for violating that norm and you can't take potential action if an actor is not complying." He argued that when countries like China and Russia take unsafe actions in space, they could face diplomatic and public pressure through social media.

Rep. Seth Moulton, D-Mass., took exception to Turner's reasoning. "Hoping one of our adversaries will be shamed on social media does not seem like an effective strategy here," he said.

But Russia and China aren't the only barriers to new treaties or other international rules covering space. The United States isn't interested either, even if certain lawmakers would like it to be, said Brian Weeden, technical advisor for the Secure World Foundation. U.S. agencies aren't pushing for new legally binding space rules because they don't want to be bound by them.

"There's also the issue that a new treaty has to be based on some sort of common concern between the parties, and right now the U.S., Russia, and China don't agree on much at all."

The current discussion on norms can serve as a good foundation for a broader discussion, he said. "But ultimately, I think the [United States] needs to step up and put something firmer on the table, particularly with regard to anti-satellite testing."

The United States instead has focused on safety issues and sharing information between countries about what's in space. It's one area where the U.S. military releases information publicly that would be kept secret if it were about Chinese or Russian movements on Earth.

"We actually publish all of our information out there so that the Russians and Chinese can get it. We have the best network out there to determine what's in orbit, and for flight safety purposes we publish that to

everyone," Brig. Gen. Richard Zellmann, the deputy director of United States Space Command, told *Defense One* during a visit to Space Command headquarters in March. "In fact, if we see Russian objects that are going to collide with Russian objects or Chinese objects with Chinese objects, we let them know. They don't always respond to us. We would like them to. But we let them know that this is an unsafe situation, much in the same way the FAA would help regulate the safety of flight."

The United States has **a lot more objects in space than any other nation:** 1,897 as of the end of last year, according to the Union of Concerned Scientists, versus China's 412 and Russia's 176. So the United States has a big interest in limiting the amount of space debris that could affect those assets. A major accident in space would also hurt the global economy, as large economic and market entities rely on satellites not only for communication but also the timing signals that guide stock trades and even ATM transactions.

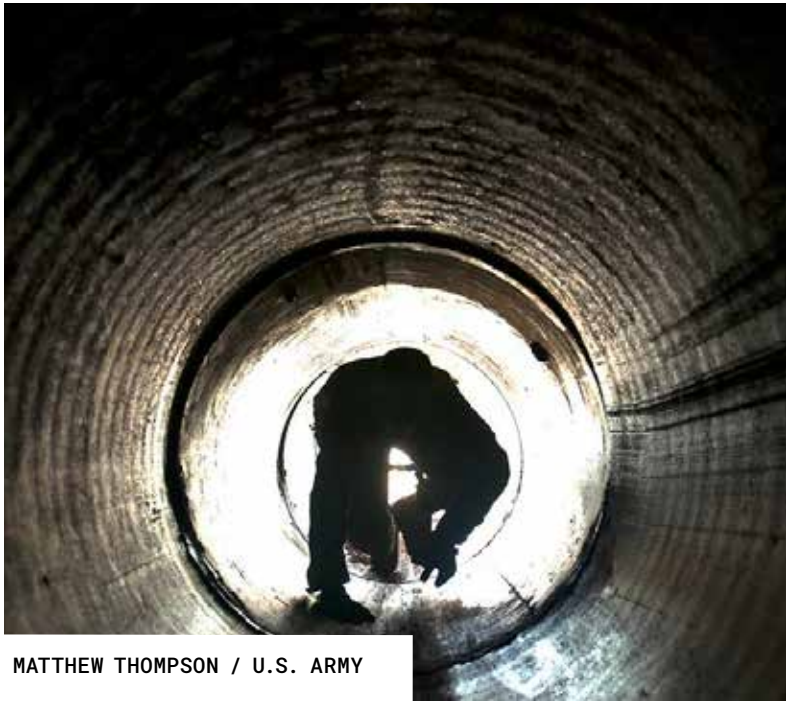
But China is rapidly fielding more satellites and even other countries' microsatellite constellations will make the job of U.S. Space Command more difficult, said Zellman.

"You have to catalogue all of those things. You have to maintain custody of all of those. One of the difficulties and one of the reasons the [United States] in general is pushing more toward a policy of responsible behavior, as opposed to any kind of treaty arrangement, is that there are some problems when it comes to verification from a space perspective. Very difficult and we don't have a lot of people up there."

It will also become much harder to characterize satellites as benign or hostile, he said. "It used to be, in the past, that we would know where an object was and that was all we cared about. Because if we knew where an object was then we could predict if something would collide with it. Now I need to know where it is… What's it doing? Why is it so close to me? Can it harm me? If so, how? And all of these things take a lot more assets to determine. That's where the challenge will be."

Discussions on space norms are continuing. The United Nations last year passed a resolution encouraging countries to look at security threats in space to find areas of common interest. This week, it **published responses** from a wide number of countries including the United States, China, and Russia.

But there's a big difference between the position of the three countries on what space safety means. The



MATTHEW THOMPSON / U.S. ARMY

latter two have been pushing for a ban on weapons in space, through a draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects, or the PPWT, since 2008. But the United States looks at weapons in space — one possibility is **anti-ICBM defenses** — as a fundamentally different issue than shooting rockets into space to cause space debris or launch satellites that can attack other satellites.

The PPWT "doesn't say anything about ground-based [anti-satellite] weapons, nor does it have any verification mechanisms," said Weeden. "Most of us believe that the PPWT is really aimed at preventing the [United States] from deploying space-based missile defense interceptors, which the Russians are concerned would undermine their nuclear deterrent."

The United States has also been reaching out to other nations to establish bilateral agreements on information sharing and norms. U.S. Space Command works with the United Kingdom, Canada, Australia, and other countries through a program called **Olympic Defender,** to share tactics and procedures for space monitoring and come to agreements about what constitutes unsafe behavior.

"What you would like to do is build a relationship today so you don't become adversaries tomorrow," said Zellman. "So from a responsible behavior perspective we encourage nations to share their data so that we have even better information than we would have otherwise… Like-minded nations have discussed how we would like to operate in a safe and professional manner in the space domain. There's reasons you want to do that. If you have an understanding of what safe and professional is and you have a misunderstanding, hopefully that misunderstanding doesn't lead to a miscalculation and that miscalculation doesn't lead to escalation." D

CHAPTER 2

CHINA'S SPACE PROGRAM IS MORE MILITARY THAN YOU MIGHT THINK

PROPOSALS FOR U.S.-CHINESE COOPERATION MUST PROCEED CAREFULLY.

BY TAYLOR A. LEE, PETER W. SINGER

On the 4th of July, China celebrated its taikonauts' **first-ever space walk** outside the country's first permanent space station, the Tiangong ("Heavenly Palace"). The extravehicular activity marked yet another major step for the country's ambitious space program, and a vivid sign of what is to come. In the next five years, China intends to collect samples from a near-Earth asteroid, conduct two lunar polar exploration missions, and finish construction of its 60-ton space station.

This remarkable growth has led to a spate of recent international space cooperation programs with China, including European Space Agency and taikonauts **training together** and a reported **42 applications of interest** for joint research programs. Some are **urging** the U.S. and China to collaborate in space as a means to dampen great power tension, though the Wolf Amendment has since 2011 effectively **barred** NASA from such cooperation.

The militarized tilt of the Chinese space program complicates these plans. Space planning and directing organizations, the ground infrastructure supporting its space programs, and the taikonauts themselves are all under the purview of the People's Liberation Army. Understanding these connections is important for any plans to cooperate with China in space, whether governmental or commercial.
On the organizational side, China's equivalent to NASA is the civilian China National Space Administration, which has a focus on the space program's international exchanges. It falls under the State Administration for Science, Technology and Industry for National Defense, which handles defense-related science and technology, including China's state-owned defense conglomerates. However, unlike NASA, the CNSA doesn't oversee China's astronauts. The organization actually in charge of China's manned space program is the China Manned Space Engineering Office, which is under China's Central Military Commission Equipment Development Department.

NG HAN GUAN / AP

ANDY WONG / AP

Likewise, the infrastructure of China's space program is also heavily militarized. The launch sites, control centers, and many of the satellites are directly run by the PLA. Taikonauts lift off from the Jiuquan Satellite Launch Center (aka Base 20 of the PLA's Strategic Support Force, its space and cyber arm); directed by the PLASSF's Beijing Aerospace Flight Control Center, with Telemetry, Tracking and Control support from the Xi'an Satellite Control Center (aka the PLASSF's Base 26); and land at one of two sites in Inner Mongolia operated by the two bases.

Finally, there is the human element. While most NASA astronauts are members of the U.S. military, others are civilian scientists and even teachers. In contrast, all taikonauts are active members of the PLASSF. They make up the Astronaut Corps under the PLASSF Space Systems Department's China Astronaut Research and Training Center.

The first astronauts to fully undergo training at the Center, which began operations in the late 1990s, were all chosen from the PLA Air Force. (An earlier effort to establish a manned space program in the 1960s and '70s faltered.) Since then, China has held two more rounds of taikonaut selection, with the most recent apparently taking some candidates outside the military, but as noted above serving under the PLASSF.
China does not always openly advertise the military

affiliation of those in its space program. For example, the Chinese language website of the China Manned Space Engineering Office shows program commander Li Shangfu in military uniform, noting his main role as director of the Central Military Commission Equipment Development Department. But Shang Hong, the deputy program commander and PLASSF Space Systems Department Commander, appears in a suit. And on the English version, there are no uniforms (or leadership personnel) to be found.

To be sure, there are many links between America's own space program and its military; for example, many launch and landing sites are military bases, such as Vandenberg Space Force Base and Edwards Air Force Base. But the degree of military control, lack of potential civilian intermediaries, the specific chain of command, and the broader "military-civil fusion" missions of some civilian institutions give China's space program a significantly stronger military bent.

China's push into space brings many potential cooperation opportunities in science, commerce, and exploration. However, the PLA's direct involvement across much of the Chinese space program means caution is warranted. Any technology or sensitive information shared with these entities is flowing at the organizational, infrastructure, and human level to the PLA. This is significant because technologies used for spaceflight and spacecraft can be applied to weapons like intercontinental ballistic missiles, while space situational awareness capabilities can also be used for anti-satellite warfare.

While there are likely areas where the U.S. government or private companies could cooperate for common interest with the Chinese space program, such cooperation should involve a clear understanding of the militarized nature of much of China's space program. To do otherwise, is to not just risk national security and intellectual property, but also to risk that such cooperation projects become future points of tension rather than their hoped-for bolstering of peace.

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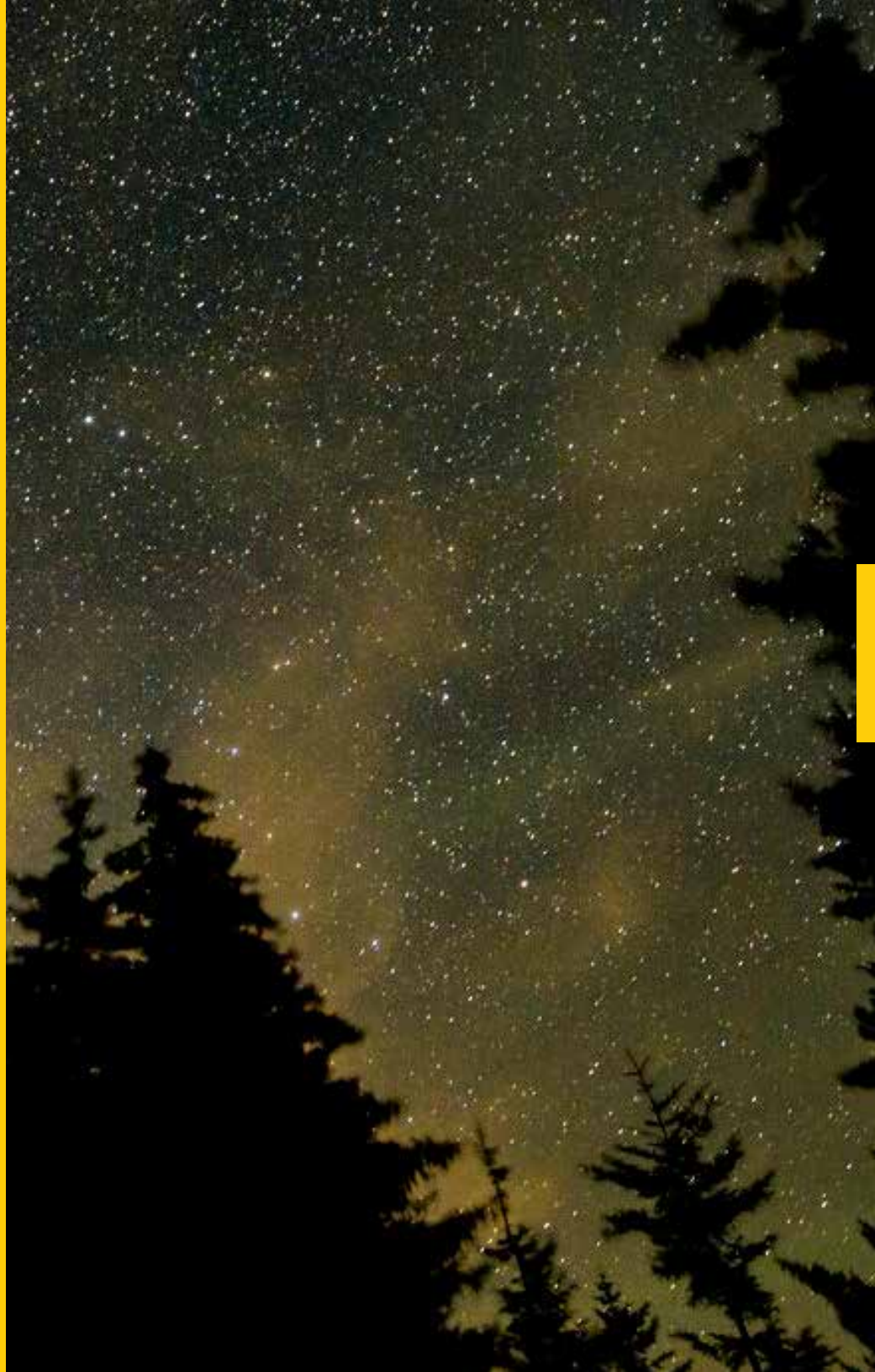
CHAPTER 3

AS SPACE JUNK MULTIPLIES, PENTAGON IS STUCK TRACKING IT FOR CIVILIANS

PRIVATE INDUSTRY IS LAUNCHING AT A PACE WITH WHICH THE MILITARY'S SPACE-SURVEILLANCE SYSTEM CAN'T KEEP UP. NOW LAWMAKERS SAY THE COMMERCE DEPARTMENT'S FIX IS RUNNING LATE.

BY JACQUELINE FELDSCHER



It's been nearly three years since the U.S. Commerce Department was ordered to start keeping tabs on satellites and orbital debris — and to relieve the Pentagon of its duty to warn the world's space operators of impending collisions. But the effort has stalled, even as orbits fill up and the danger grows.

Then-President Trump's 2018 **directive** was meant to allow the Defense Department's orbital trackers to go back to their original mission: using their sensors to protect national security assets in space. Commerce was supposed to build a more comprehensive tracking system that combined the U.S. military data with information from commercial tracking services and other governments. This new public database would notify civil and international operators when their satellites — or crewed spacecraft — were in peril.

But that handoff stalled amid staff turnover in the Office of Space Commerce and, later, the presidential transition. Now as the pace of space launches accelerates, the likelihood of collisions is high and rising — and so, some industry officials say, is the chance that America's longstanding leadership in international space policy may slip away.

"While they're stuck in neutral, they're ceding a lot of initiative to other efforts globally," said Jim Cooper, a senior systems engineer at **COMSPOC Corp.,** a space situational awareness **spin off** from Analytical Graphics Inc. He pointed to a European Union **working group** tasked with setting guidelines for best practices and norms of behavior. China is also **investing** in its own capability to track objects in space.

Currently, the U.S. government's space tracking mission is still handled by the Pentagon — specifically, **Space Command** — which collects data on orbiting objects and alerts companies and other governments when an accident is possible. That means if a Chinese satellite is on a collision course with a piece of space debris, it's the military that makes the call to alert foreign officials to the problem.

The mission has grown exponentially as companies like **SpaceX** and **OneWeb** launch mega constellations with thousands of satellites. As space gets more congested, the number of times another satellite or piece of debris flies within one kilometer of a satellite has **doubled** from 2,000 per month in 2017 to 4,000 per month today.

That means a growing amount of work for both military personnel, who must analyze mountains

of data and alert satellite owners about any trouble, and satellite operators, who are having to move their satellites more frequently to avoid collisions. Trump's 2018 order aimed to lift the Pentagon's burden and improve tracking overall. But Congress only began funding the effort last December, when it passed the 2021 omnibus spending bill. The bill contained $10 million to enable the Office of Space Commerce to get moving on a pilot space-traffic management program.

Prompted by questions this week from Defense One, members of Congress asked the Office of Space Commerce how it is planning to spend the money, but the agency referred lawmakers to an overdue spending plan that was expected 45 days after the omnibus funding bill passed in December, according to a staffer at the Senate Commerce, Science and Transportation Committee. Lawmakers have not yet seen that plan, the staffer said.

"We are concerned that rather than taking action to obtain and compile commercially available [space situational awareness] data and utilize existing cloud computing capabilities to build an open-architecture data repository, [the National Environmental Satellite Data and Information Service] and the Office of Space Commerce are only commissioning further studies," the staffer said.

The office "plans to initiate space traffic management pilot activities," a spokesperson for the National Oceanic and Atmospheric Administration, which oversees the Office of Space Commerce, told Defense One in a statement.

Some in the space community hoped the Commerce Department would contract with commercial tracking companies to do the mission cheaply, allowing the government to buy the data rather than buying the sensors that collect it. One such company, Silicon Valley-based startup LeoLabs used its network of ground-based radars in January 2020 to predict two defunct satellites would pass between 13 and 87 meters of each other, a similar probability as the military's own catalog.

The question of whether the Commerce Department should take over this mission has already been extensively studied. Congress previously directed the National Academy of Public Administration to evaluate which agency is best suited to conduct space traffic management.

The findings recommended that the Office of Space Commerce conduct the mission, concluding that the Defense Department system is not precise enough to meet the commercial sector's needs and is also not scalable to handle the growing number of objects in orbit.

"Commercial operators increasingly view today's DoD surveillance and warning system as inadequate to achieve safe operations in today's commercial space environment," the report says. "It is a legacy system that is tied to [a] sensor network with software geared toward the system's original national security purpose of providing early warning of nuclear missile attack."

Because industry is launching at a pace with which the Pentagon system can't keep up, Cooper worried about the potential for a collision in orbit, which could make entire areas of space unusable if they created a cloud of dangerous debris.

"The progress with which commercial is moving forward and continuing to populate space for their purposes is outpacing spaceflight safety regime that should be following it and that's absolutely coming with increased risk," he said.

The National Academy of Public Administration report also recommended that lawmakers pass legislation to authorize the shift. A proposal to do so is in the **Endless Frontier Act**, which is working its way through Congress.

The lack of action is likely due to the change of administration, since many of the personnel who were pushing for this during the Trump administration are gone, said **Brian Weeden**, the director of program planning at the Security World Foundation. He pointed specifically to the tumultuous transition period, and the fact that no one has been named to permanently lead the Office of Space Commerce yet.

Kevin O'Connell, the director of the Office of Space Commerce in the Trump administration, "and his staff were pushing through a change in the organization's culture and responsibilities, and without that sort of active push for change, organizations tend to revert," Weeden said. "It's not that the Biden team has come in and said we're going to go in a different direction, it's the lack of attention."

Space Command did not return a request for comment, but the Pentagon has publicly said it's eager to offload this mission. Transferring the mission to the Commerce Department, "where it can be better managed," would allow the Defense Department to focus only on tracking priorities that affect national security, Gen. James Dickinson, the commander of U.S. Space Command, **said in January**.

CHAPTER 4

PROPOSED SPACE NATIONAL GUARD GATHERS MOMENTUM

A SPACE-FOCUSED BRANCH OF THE GUARD WOULD AIM TO GIVE THE SPACE FORCE "A SURGE-TO-WAR CAPABILITY" IN TIMES OF CONFLICT.

BY JACQUELINE FELDSCHER

The National Guard will soon deliver recommendations to the defense secretary on how to establish a space-focused component of the part-time volunteer force, an effort the Guard's top general calls one of his "most pressing concerns."

But lawmakers want to know what the new organization will cost, suggesting they may have some of the same concerns about soaring costs and bureaucracy that hounded the Space Force when it was established in December 2019.

Gen. Daniel Hokanson, the chief of the National Guard, said he's "fairly close" to briefing Defense Secretary Lloyd Austin on recommendations to establish a Space National Guard, and that he has already briefed Deputy Defense Secretary Kathleen Hicks.

He's expecting to meet with acting Air Force Secretary John Roth on Wednesday to prepare for the meeting with Austin, but he said the Air Force secretary and Chief of Space Operations Gen. Jay Raymond have already agreed on the plan to establish a space-specific guard in addition to a combination active and reserve component.

"If they have invested their career in the space mission, will there still be a home for them in the Space National Guard?" Hokanson asked, before saying that establishing a Space National Guard is "the right thing to do."

Rep. Betty McCollum, D-Minn., who chairs the House Defense Appropriations Subcommittee, told Hokanson she'll submit follow-up questions on the price tag for setting up both a space reserve and guard, as well as what it would actually look like across all 50 states. She also said she would submit questions about how much Air Force infrastructure and facilities could be shared, a concern similar to that of lawmakers when Congress was debating the Space Force.

A Congressional Budget Office report from June 2020 estimated a Space National Guard would cost at least $100 million per year.

There are now about 2,000 members of the National Guard working on space missions in eight states: California, Florida, Colorado, New York, Ohio, Wyoming, and Arizona, according to a fiscal 2021 fact sheet from the National Guard Association of the United States.

Space is becoming the latest battlefield for great power competition. China has about 400 operational

satellites today, but that number is expected to grow to 1,000 by 2030, Brig. Gen. Richard Zellman, the deputy chief of staff for the strategy, plans, and policy directorate at U.S. Space Command, told Defense One. And Russia has developed multiple space-based weapons, including satellites that can maneuver in orbit to target American assets.

In response, Congress established the Space Force in December 2019 as the standalone sixth branch of the military.

But the National Guard has also been **pushing to get a piece of the mission** in orbit as threats grow.

"There will be a standard to be a space warrior in the…Space Force and I believe that it is important that the space capability currently in the National Guard should move into the Space Force," former National Guard chief Gen. Joseph Lengyel told Congress in March 2020.

Having a National Guard component of the Space Force would also give the new branch "a surge-to-war capability," the fact sheet said.

Some states are charging ahead without Congress. Though lawmakers on Capitol Hill have not authorized the establishment of the space organization, the Colorado General Assembly **passed a bill** in April that added the Colorado Space National Guard to state statutes, saying Congress is "likely" to create such an office in the fiscal 2022 National Defense Authorization Act.

The need for a space guard is mostly about personnel, according to Brian Weeden, the director of program planning at the Secure World Foundation, a nonprofit dedicated to space sustainability. The active-duty military requires troops to either get promoted or leave the service, and to move around a lot, something that doesn't always mesh well with the highly-technical workforce military space organizations are trying to recruit.

Having a space guard, where troops have more flexibility, Weeden argues, could help the Defense Department bring talent from the private sector into the military part-time, and help retain those people if they can serve in a job much longer than they could on active duty.

CHAPTER 5

IF CHINA AND THE US CLAIM THE SAME MOON-BASE SITE, WHO WINS?

RELATIVELY FEW CRATERS ARE ATTRACTIVE, AND THERE'S NO CONSENSUS ABOUT AVOIDING CONFLICT OVER THEM.

BY TARA COPP

There's a not-so-quiet race back to the moon underway, but the two largest factions, with China and Russia on one side, and the United States and its partners on the other, are not recognizing each others' proposed rules on what's allowed once they get there.

Lawmakers and space policy analysts are concerned: How do you avoid conflict in space if the international laws and policies on Earth no longer apply?

"Many terrestrial military doctrines are not applicable in space, or at least not as applicable. If you get beyond 50 miles, or at least 62 miles, suddenly different rules apply. We need to start being aware of that," says Rep. Jim Cooper, D-Tenn.

There's already some aggressive international elbowing over the rules of satellite operations. As with the moon, there's no consensus yet on how to respond to aggression in Earth orbit, the head of U.S. Space Command Gen. James Dickinson told attendees at the Sea Air Space conference.

"The behavior of some of our adversaries in space may surprise you," Dickinson said. "If similar actions have been taken in other domains, they'd likely be considered provocative, aggressive, or maybe even irresponsible. And in response, the U.S. government would take corresponding actions using all levers of national power, a demarche, or a sanction or something to indicate we won't tolerate that type of behavior, but we're not quite there yet in space policy."

In 1967, the U.N. General Assembly adopted a treaty on the use of outer space that promised cooperation and banned nuclear weapons, military maneuvers, and military installations off-planet. The agreement also requires countries to take "appropriate international consultations" before making any moves that would "cause potentially harmful interference" with other space programs, and allows countries to "request consultation" if they believe such interference is likely.

This treaty "forecasted very well" the issues that that might arise as space exploration expanded, said James Lake, a senior associate at Canyon Consulting who co-wrote an article on lunar security issues in August's Space Force Journal. "The question remains: is that text sufficient? That's something we are going to find out fairly soon."

Notably, a treaty annex that prohibits military activity on the moon went unratified by Russia, China, and the United States. It's likely both the

China-Russia and U.S.-led partnerships will begin their moon bases without any sort of agreement between them in place.

In June, the China National Space Agency and Russia's Roscosmos announced they would begin surveying locations for their International Lunar Research Station this year, and pick a site by 2025.

In 2020, NASA, together with the nations partnering with the U.S. under the **Artemis Accords**, outlined its **Artemis Base Camp** project. The Artemis nations aim to to send astronauts back to the moon by 2024.

In addition to those two major alliances, private firms such as **Blue Origin** are also working on **private moon bases** .

But there may be only a few locations on the moon where it would make economic sense to build a base, said Bleddyn Bowen, a professor at the University of Leicester and author of **War in Space: Strategy, Spacepower, Geopolitics**.

"Water ice, for example, might be in limited pockets, for example, making the territories around certain craters on the polar regions, perhaps more desirable," Bowen said.

So what happens if each decides on the same crater as the best spot to begin moon operations?

"If you have a situation like that, where you're trying to do something in the exact same spot, it's essentially who gets there first," said Alex Gilbert, a researcher and space resources doctoral student at the Payne Institute at the Colorado School of Mines. "And if you're not first, then the only alternative is to forcibly remove the current occupant."

The Artemis nations have endorsed the idea of "safety zones" on the moon, to require communication between two space operations that want to operate in the same area.

"Even if you set up a base and you declare a safety zone, people can still go into that safety zone. It's just something that it's really to be used as a tool to get parties to talk to each other," he said.

But there's already a risk those zones will instead be used as a way to rope off sites from competitors, he said.

"One thing that is really kind of important to understand about safety zones is that everyone kind of has their own definition," Gilbert said.

"Whoever gets there first can use the resources, but no nation can 'claim' the territory," said Laura Duffy, a space systems engineer with Canyon Consulting who co-wrote "**Cislunar Spacepower, The New Frontier**," with Lake with Lake in this month's Space Force Journal.

It's not just water, but rare earth metals and helium-3 that will be up for grabs on the moon, making a treaty for its peaceful use critical, Duffy said.

"The Moon must be available for open and free use, according to the Artemis Accords and Outer Space Treaty," she said.

But neither Russia nor China are expected to join the Artemis Accords.

Until now, U.S. space defense has largely concentrated around the objects orbiting Earth. That changed this year, when the U.S. Space Force and U.S. Space Command **were tasked** with protecting U.S. assets up to 272,000 miles away, a volume called "cislunar space" that extends slightly beyond the Moon's orbit.

They have some catching up to do, said Rep. Frank Lucas, R-Okla., the ranking member of the Science, Space and Technology Committee. Lucas believes the 2019 landing of China's Chang'e-4 spacecraft on the far side of the moon should have been this generation's Sputnik moment.

"But with all of the chaos in the world, and COVID-19, and all of this environment we're working in, we missed it," he said.

Those far-side moon operations meant China had developed the technology to operate and communicate with its landed rover out of line of sight—and out of view of almost all of the U.S. ability to see what they're doing.

The achievement allows China "to accomplish scientific, military, or other endeavors without observation or repercussion," Duffy and Lake wrote. The authors urged that the U.S. needs to speed its monitoring efforts, such as the **Cislunar Highway Patrol System**, or CHPS, that is being developed by the Air Force Research Laboratory.

"In the future, other defensive and offensive assets will be needed to assure the open and peaceful use of cislunar space," the authors argued. D

CHAPTER 6

HYPERSONIC MISSILE DEFENSE MAY DEPEND ON LOW EARTH ORBIT SATELLITES

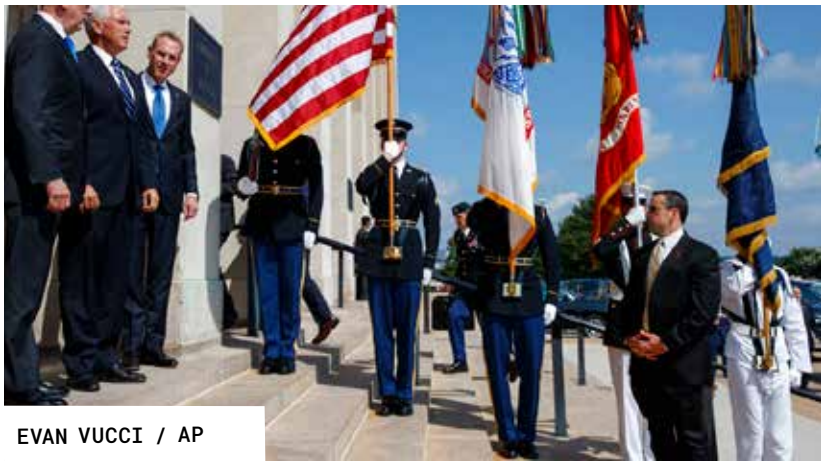
SENSORS IN RELATIVELY LOW ORBITS MAY BE THE BEST WAY TO SPOT SUPERFAST MISSILES—BUT THEY CAN'T DO THE JOB ALONE.

BY TARA COPP

WALLOPS ISLAND, Va.—The Antares rocket that's launching Tuesday to replenish the International Space Station will be carrying a camera sensor with a unique missile-defense task: to begin gathering data that could help the U.S. more quickly detect and defend against hypersonic missiles.

The Prototype Infrared Payload, nicknamed "PIRPL," was developed by Northrop Grumman, the Space Development Agency and the Missile Defense Agency to see how low Earth orbit, or LEO, satellites might be used to help detect hypersonic missiles.

"So, tracking layers—looking at missile warning, missile tracking, those kinds of defense-related missions—those are usually done at higher orbits like geostationary orbit, with bigger sensors on longer-life satellites. Sometimes we call them national assets," said an SDA official who briefed reporters on the condition they not be named.



EVAN VUCCI / AP

But geostationary satellites operate at an altitude of 35,000 kilometers from the Earth's surface, which makes it more difficult to rapidly discern the dim infrared signatures of hypersonic missiles against all the infrared noise, or clutter, generated by the Earth. A low Earth orbit satellite operates at about 1,000 kilometers, "which gives me a ton of better detection capability," the official said.

"A maneuvering advanced hypersonic missile is not bright and that is why we need to innovate," the official said.

When a target of interest is identified, the images collected have to be run through a decluttering process to refine out that dim signature.

SDA and MDA have been working toward having a network of low Earth orbit satellites that could speed that detection.

"We have some tough threats out there these days. If we can show we can do those missions at a lower Earth orbit, we are able to get much closer to the source and they look much brighter," the official said.

OHN RAOUX / AP

But the satellites can't do the job alone. In order to quickly spot a hypersonic missile's heat signature, they need to know the existing signatures of the atmosphere, clouds, land, and water as they appear in that low Earth orbit.

"But we don't have that empirical data," the official said.

PIRPL will be mounted on a panel on the Cygnus spacecraft riding atop Tuesday's Antares rocket launch, and once in orbit, begin to collect shortwave and mid-wave infrared imaging data "nearly simultaneous through a rapidly moving filter wheel that will let us understand: 'What does the atmosphere, clouds, Earth's surface, land, and ocean all look like at various times of the day and night, from this type of sensor in a low Earth orbit'" to build those data points, the official said.

PIRPL will also be used to help MDA better define what capabilities the future low Earth orbit tracking satellite network will need, the agency said in a statement to Defense One.

"It's imperative we have the capability to look down on the warm Earth and pick targets out of that scene," the agency said in a statement. "The Prototype Infrared Payload will help inform MDA's development of the payload for the Hypersonic and Ballistic Tracking Space Sensor, which is on course for an on-orbit demonstration using two prototype space vehicles in 2023. These space vehicles will demonstrate the unique sensitivity and fire-control quality of service performance necessary to support the hypersonic kill chain." D

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