OPINION

THE WARNING

By W.J. Hennigan Graphics by Taylor Maggiacomo and Jeremy Ashkenas Mr. Hennigan writes about national security for Opinion.

U.S. military personnel at Space Command, in Colorado Springs, have kept a close eye on Cosmos 2553 ever since it reached orbit. Bathed in the bluish glow of their computer screens, they sit and watch what's going across all of space day after day, tracking the latest information on satellite constellations, coming rocket launches and the daily operation of the space-based systems that shape modern life.

But Cosmos 2553 is different. It circles Earth every two hours in a region called a graveyard orbit. Only 10 other satellites are out there, and all of them have been dead for years. The area is rarely used in part because it's inside the Van Allen belts, zones of high radiation that encircle the planet.

That's why Moscow claims Cosmos 2553 is there — to test out "newly developed onboard instruments and systems" against radiation. But what it's really doing, U.S. officials say, is testing components for a Russian weapon under development that could obliterate hundreds, if not thousands, of critical satellites. Cosmos 2553 isn't armed, but it does carry a dummy warhead, one of several details being reported here for the first time. So while the orbiting satellite poses no imminent danger, the officials caution it does serve as a forerunner to an unprecedented weapon.

THIS ARTICLE IS PART OF THE OPINION SERIES AT THE BRINK, ABOUT THE THREAT OF NUCLEAR WEAPONS IN AN UNSTABLE WORLD. READ THE OPENING STORY HERE.

Although they are almost invisible in our day-to-day lives, satellites increasingly control how we live. Everything from pumping gas to trading stocks to checking tomorrow's weather forecast depends on satellite signals, and the world's collective appetite for these systems is growing. More satellites have been launched into orbit in the past five years than in the previous six decades as commercial companies and governments spend billions to build new constellations for communications, Earth imagery and other services. Most of them travel around Earth in a part of space called low-Earth orbit, an area within 1,200 miles of the planet.

Satellites in low-Earth orbit in 1970



Source: T.S. Kelso, CelesTrak • Note: Satellites for past years shown as of Jan. 1.

U.S. intelligence analysts haven't determined if it's this region or some other area that Russia may one day threaten if it ever deployed such a device. In any scenario, a nuclear weapon detonated in outer space wouldn't have a localized impact like a direct hit with a missile strike. It would be indiscriminate, affecting all nations. If the Kremlin decided to use a Sput-nuke, as the device is sometimes derisively called, it holds the unambiguous potential to disrupt the future of America's military space operations and the lives of hundreds of millions of civilians around the globe.

Once considered a largely peaceful domain, space is now viewed by many American lawmakers and military commanders as a place where the next major global conflict might unfold. If Moscow is working on a space nuke, it would be merely one of dozens of space weapons under development or already in use by Russia, China and the United States. All three nations have tested high-flying missiles capable of targeting space systems from the surface and have lasers, signal jammers and other devices that can disrupt space operations. Russia has deployed nesting doll satellites (in which one satellite births a smaller satellite that is maneuverable and armed with a projectile) and China and the United States have demonstrated grappling satellites, which can sidle up to another satellite and tug it out of its orbit with robotic arms.

It may sound as if these technologies were torn from the pages of a science fiction novel, but none of them come close to doing what a nuclear weapon could in space: wipe out clusters of satellites at once.

As the risk of conflict in space climbs, there are surprisingly few international agreements to safeguard against military action there — and no established norms. There are just two major pacts governing nuclear weapons in the cosmos, both of which predate Neil Armstrong's first steps on the moon. The Limited Test Ban Treaty, which prohibits nuclear tests in the atmosphere, underwater or space, was signed by the United States, Britain and the Soviet Union in 1963. The Outer Space Treaty, which was first signed less than four years later, bans deploying "nuclear weapons or any other kinds of weapons of mass destruction" in orbit. Today, both decades-old agreements are proving shaky. With a new generation of weapons under development, space experts see a rising potential for miscalculation, misinterpretation and aggression.

While the American government says it has tracked Russia's nuclear anti-satellite program for nearly a decade, it's impossible to independently verify its claims about Cosmos 2553. But even the prospect of such a device should alarm the more than 90 nations with at least one satellite in orbit. The potential threat to the world's satellites may emanate from Russia today, but it doesn't end there. Any nation with ballistic missiles and nuclear weapons, like North Korea, holds the potential to reverse the progress of the space age with a single detonation. It is a development that the world must not look on with indifference. In his first administration, Donald Trump created the Space Force, a clear indication that he recognizes the threat of the mounting militarization and weaponization in outer space. In his second term, it's imperative for Mr. Trump to lead an international effort that aims to improve space traffic management, open new communication channels with adversaries and slow the rapid development of space weapons that is already underway.

We rely on space more than ever

Perhaps the easiest way to understand the extent of our reliance on space is gazing upon the night sky. It doesn't take long before Starlink satellites come into view, streaking among the celestial bodies. With around 6,500 active satellites, Starlink, operated by Elon Musk's SpaceX, accounts for more than half of the world's inventory. Starlink provides high-speed internet to customers who purchase terminals and is accessible almost anywhere on the planet, including Ukraine, where it has proved crucial to Ukrainian troops on the battlefield. (Moscow has since said any company that provides satellite service to Kyiv's forces could become a target.)

SpaceX has plans to greatly increase the size of its constellation in the coming years. That's a lot on its own, but Amazon also has plans to build a system to compete with Starlink in the next few years. China hopes to launch 40,000 of its own such satellites in the next decade, and the Pentagon is set to spend nearly \$14 billion over the next five years to build its new system of missile-targeting satellites in low-Earth orbit. All told, the global space economy is expected to grow to \$1.8 trillion by 2035, roughly three times where it stood in 2023, according to a recent industry analysis.

The U.S. space defense budget has spiked

The space economy has tripled in size since 2005



It's hard to overstate modern armed forces' reliance on space. They use it to drop bombs on targets, communicate, navigate and track potential incoming attacks. When Iran launched around 200 ballistic missiles toward Israel in early October, for instance, U.S. forces knew well in advance where many of the missiles were positioned, the split second they launched and the approximate locations they were on course to hit. That so few of those missiles got near their targets is proof of the extraordinary technological advantage of America and its allies in space. This dominance is also an Achilles' heel. U.S. military analysts believe the dependence on such systems is seen as a wartime vulnerability by our adversaries, including China and Russia.

Taking out these satellites, particularly in a conflict, could even the playing field. The conventional anti-satellite weapons that Beijing and Moscow have developed could render orbiting satellites useless. The United States responded to this growing threat by launching a satellite constellation last year code-named Silent Barker to monitor its spacecraft, and the Space Force continues to enhance its ability to fend off potential attacks.

> United States

2,000 objects launched in space per year

1.000

The U.S. is launching satellites at unprecedented rates

1960

During the Cold War, the Soviet Union dominated satellite launches. The United States has leapt ahead with the advent of SpaceX.

Other						
Britain						
China Russia						
	2020	2010	2000	1990	1980	1970

Source: Our World in Data; United Nations Office for Outer Space Affairs • Note: Objects launched include satellites, probes, landers, crewed spacecraft and space station components.

The discovery of Cosmos 2553 has generated serious contemplation at the highest levels in Washington about the worstcase scenario, including examining military policies and considering whether to entrust military commanders with more options and tools for conducting conventional counterattacks.

What if a nuclear weapon detonated in space?

If a war in space is difficult to fathom, a nuclear detonation is unthinkable. The devastation would be counted not in casualties but in mass disruption to our everyday lives, from vital services like weather forecasting and navigation to supply chains. Many of the larger national security satellites — comparable in size to school buses — are much farther from Earth, in what's called geostationary orbit, and contain electronics designed to withstand radiation from a nuclear detonation. But thousands of satellites in low-Earth orbit have little to no protection and are profoundly vulnerable to such an attack.

Satellite armed with nuclear warhead

Low-Earth orbit

Much of what we know about the effects of nuclear weapons in space stems from two series of U.S. tests conducted during the Cold War, code-named Operation Argus and Operation Fishbowl.

One test in 1962, called Starfish Prime, knocked out a third of the two dozen satellites in orbit at that time.

Here's what would happen if a weapon detonated near low-Earth orbit today.

There would be no sound, no fire and no shockwave. There would be no mushroom cloud.

From the surface, people would see a brilliant light, followed by dazzling auroras generated by a burst of electrons colliding with gases in the atmosphere.

The detonation would disable and destroy everything in its immediate vicinity, turning satellites into unguided projectiles that could crash into one another. Objects in low orbits travel at around 17,000 miles per hour. Any debris — even as small and light as a paint chip — would pose real danger to other objects or people in space.

Meanwhile, the burst of intense radiation produced by the

detonation would be captured by Earth's magnetic field.

Swirling away from the blast point, the charged particles would form a shell of radiation that would linger for weeks, if not years — long enough to gradually fry the onboard electronics of surviving satellites orbiting close to Earth.

U.S. intelligence analysts have determined low-Earth orbit would be unusable for an unknown period, depending on the size of the blast.

Predictions about how an event like a nuclear detonation in space would affect human life are difficult to pin down. Any astronauts aboard the International Space Station would likely face grave danger and future human spaceflight would be imperiled for some time. A U.S. National Intelligence Council analysis of the possible economic damage caused by a nuclear blast in low-Earth orbit warned that there would be a widespread impact on travel and shipping, banking and financial markets, the oil and gas industries and farming and supply chains. Even a detonation closer to Earth could have catastrophic effects. Such a blast high above a major city may not harm the population, but the bomb's electromagnetic pulse could cause crippling blackouts and permanently damage electrical grids. The Soviets demonstrated these effects during a series of nuclear tests, codenamed the K Project, in the early 1960s.

U.S. intelligence had been tracking Russia's interest in developing a nuclear anti-satellite weapon years before Cosmos launched in 2022, officials say. Once they detected it, just weeks before Russia invaded Ukraine, military officials at Space Command's Joint Operations Center in Colorado Springs started to pull together information from various intelligence agencies. They keyed satellite sensors onto the Cosmos 2553 and told leaders at the Pentagon what they believed they had found: a working model for Russia's nuclear anti-satellite program that relays data on how an operational weapon would perform, should it be placed in orbit.

All this was kept in tight secrecy until last Feb. 14, when Michael R. Turner, an Ohio Republican who is the chairman of the House Intelligence Committee, put out a cryptic statement calling for the release of classified material about a "serious national security threat." As more information trickled out of Washington about the potential weapon, President Vladimir Putin of Russia publicly dismissed the allegation. "Our position is clear and transparent: We have always been categorically against and are now against the placement of nuclear weapons in space," he said. The Russian Embassy in Washington did not respond to a request for comment.

Although the Soviet Union, now Russia, signed the 1967 Outer Space Treaty, which forbids nuclear weapons and other weapons of mass destruction in space, that's not exactly easing anyone's mind. At the United Nations in April, Russia vetoed a resolution that reaffirmed provisions in that treaty. And in recent years, both Russia and the United States have walked away from several Cold War arms agreements as relations between the countries have worsened.

There are also several United Nations agreements that regulate various aspects of outer space, but space-faring countries have yet to solidify norms and conventions for responsible actions in orbit. How close can one nation's satellite approach another nation's satellite? When they inadvertently draw close, which way should they turn to avoid crashing? How should satellite operators communicate with one another? It took centuries in maritime and decades in aviation law to establish such rules and identify safe and professional behavior. It's now time for outer space.

The foundations of space law were set almost 60 years ago

There are only two major treaties that govern nuclear weapons in space. The first, the Limited Test Ban Treaty, was signed just a year after the largest nuclear weapons test in space.

Limited Test Ban Treaty OCTOBER 1963 The U.S., the Soviet Union and agreed to stop testing nuclear of the atmosphere, underwater and	Britain weapons in nd in space.				
RESCUE LIABILI AGREEMENT CONVE	TY NTION				Today
1970	1980	1990	2000	2010	2020
Outer Space Treaty OCTOBER 1967 Foundation of international space law that governs	REGISTRATION MOON CONVENTION AGREEM	N ENT			

Source: United Nations Office for Outer Space Affairs

outer space, the moon and other celestial bodies.

Although U.S. administrations including President Biden's have tried to move the world closer to a consensus on the rules of the road, progress has been slow. One hundred and fifty-five states, including the United States, voted in favor of a United Nations resolution calling to halt debris-generating anti-satellite missile tests from Earth, but Russia and China voted against the measure. After Russia vetoed the reaffirmation of the Outer Space Treaty, Moscow, along with Beijing, introduced a competing resolution calling for a ban on the placement of all weapons in outer space. That also failed after the United States and other nations dismissed it as a ploy to distract attention from its true intentions.

Therein lies the challenge. The United States, Russia and China are growing further apart rather than coming together to forge such agreements. Verifying that a satellite isn't carrying a nuclear weapon or some other harmful payload becomes even more difficult once it's put into orbit. And writing legal definitions of what qualifies as a space weapon is a formidable task because of dualuse capabilities. A grappling satellite, for instance, that does the necessary work of grabbing and pulling dead satellites from orbit could also in theory be used to remove another nation's functioning national security satellite from its position, though no nation is known to have done so to date.



President Lyndon B. Johnson and Ambassador Anatoly Dobrynin of the Soviet Union in the White House East Room on Oct. 10, 1967, formally putting the Outer Space Treaty in effect. Lyndon B. Johnson Presidential Library, via YouTube

There are clear points where collaboration can still happen that would benefit all countries — and provide the foundation for future agreement. A United Nations report in May noted the growing congestion in low-Earth orbit and urged states to consider an international framework for nations to share information on satellites and space debris. It echoes a topic already under discussion in Washington about developing an effective channel with Moscow and Beijing to coordinate space traffic. Such a safety mechanism could prove useful, particularly during a diplomatic or military crisis, to avoid an honest mistake like an unintended collision being interpreted as an act of war.

The U.S. military is on board for this kind of open channel, beyond the limited ones in operation now. "We want to have a way to deconflict and have space safety discussions, which would enable those tenets of responsible behavior," said Gen. Stephen N. Whiting, who oversees Space Command.

American leadership is needed to bring other nations into the hotline and to maintain peace — however uneasy — in space. When news of Russia's nuclear anti-satellite program became public, Secretary of State Antony Blinken reached out to his counterparts in India and China to help apply pressure on Moscow about the program. Mr. Trump should try to expand on that effort when he re-enters the White House. Rather than fuel an accelerated space arms buildup, he should instruct his National Security Council to mobilize a diplomacy-led, multilateral effort to draw up rules of behavior in outer space that reflect the technological reality of today.

A good start would be for Mr. Trump to call out Cosmos 2553 by name — something the Biden administration hasn't publicly done — and further express the need to build on the half-century-old Outer Space Treaty with China and Russia. The president-elect might opt to consult Mr. Musk, who as founder of SpaceX has much to lose with a military confrontation in space. As he no doubt knows, the world has spent decades delicately constructing the space architecture that enables our daily life. Any act of war in space, much less a nuclear detonation, would needlessly put all that at risk.

History has shown that wherever there's a potential for financial or strategic advantage — on land, in the air or at sea — it's accompanied by the prospect of war. The peril now looms above us, and it can no longer be overlooked.

READ MORE FROM AT THE BRINK

Nuclear War Is Called Unimaginable. In Fact, It's Not Imagined Enough.

W.J. Hennigan



An Introduction: It's Time to Protest Nuclear War Again

Kathleen Kingsbury

How America Made Nuclear War the President's Decision

W.J. Hennigan

How China's Nuclear Ambitions Have Changed the World

W.J. Hennigan

The Victims of U.S. Nuclear Testing Deserve More Than This

W.J. Hennigan

The Human Toll of Nuclear Testing

W.J. Hennigan

Are Americans Ready to Understand Aug. 6?

Kathleen Kingsbury, W.J. Hennigan and Spencer Cohen

Audio Essay: Hiroshima Survivors on the New Arms Race

Kathleen Kingsbury and W.J. Hennigan

America's \$1.7 Trillion Nuclear Makeover

W.J. Hennigan

W.J. Hennigan writes about national security issues for Opinion from Washington. He has reported from more than two dozen countries, covering war, the arms trade and the lives of U.S. service members.

This Times Opinion series is funded through philanthropic support from the Carnegie Corporation of New York, Outrider Foundation and the Prospect Hill Foundation. Funders have no control over the selection or focus of articles or the editing process and do not review articles before publication. The Times retains full editorial control.

The Times is committed to publishing a diversity of letters to the editor. We'd like to hear what you think about this or any of our articles. Here are some tips. And here's our email: letters@nytimes.com.

Follow the New York Times Opinion section on Facebook, Instagram, TikTok, WhatsApp, X and Threads.

Note: Satellites, launch path and detonation in opening animation are for display purposes only.

Additional production by Gus Wezerek. Additional reporting by Spencer Cohen.