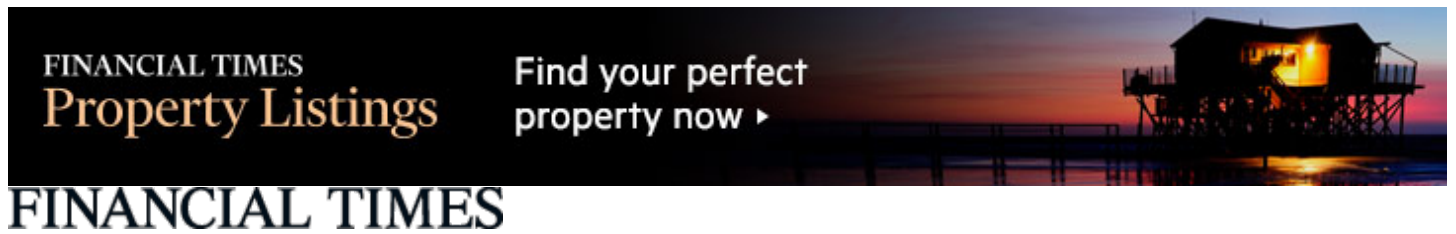


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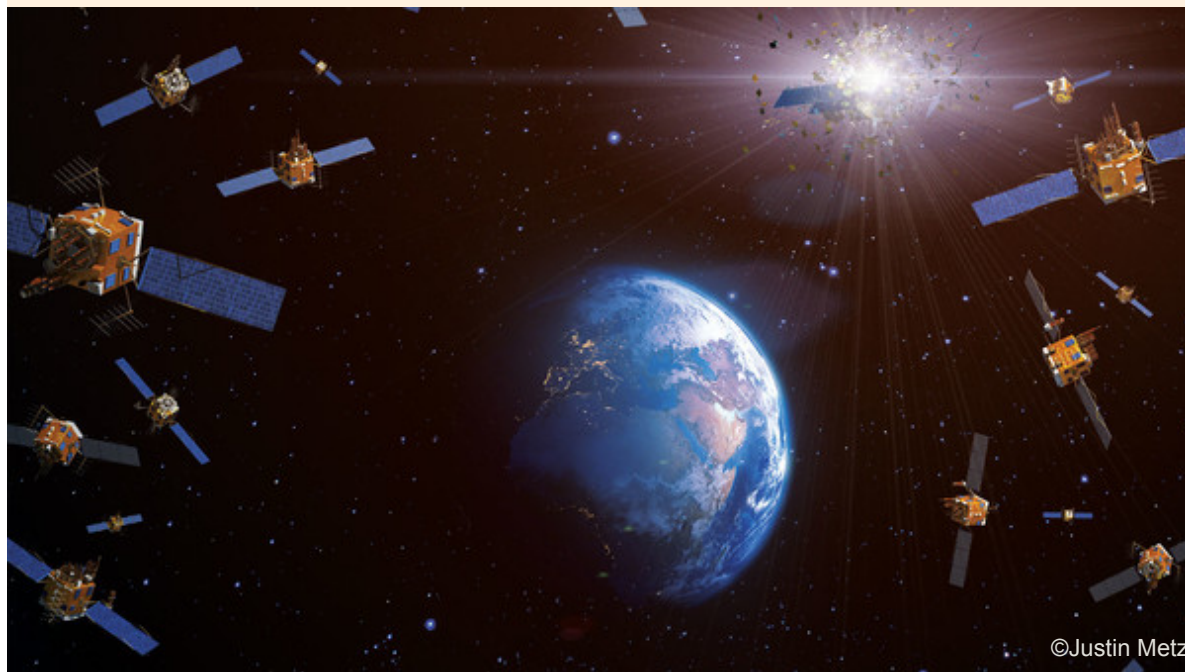
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Satellite wars

Sam Jones

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A new arms race in our skies threatens the satellites that control everything from security to communications



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An unlikely memorial runs across the middle of the marketplace in Kettering — an otherwise unremarkable English market town. This slab of granite, set into the paving as part of a timeline of local history, reads “Russian Satellites: Grammar School Beats Nasa”. Etched into the stone is the distinctive outline of a sputnik orbiter.

Kettering Grammar School — like the space race — is long gone. But for a period it was on the front line of the extraterrestrial battle between Washington and Moscow. The Kettering Group — the school’s enthusiastic science masters and their eager pupils — became the world’s foremost amateur satellite sleuths, tracking secret Soviet launches and uncovering the location of a previously secret Russian cosmodrome from the workaday shire town.

As the cold war passed into history, so did the group. Geoff Perry, the main teacher and leader, died in 2000. But some of his former pupils never lost their enthusiasm for

tracking the orbits of satellites in the skies above us. In 2014, an email from one of them hit my inbox. Did I know much about satellites, it asked? Perhaps I should look into this curious new object?

“In May 2014 there was a regular Russian rocket launch that put four satellites up into orbit,” recalls Bob Christy, a former Kettering pupil. “But one of them wasn’t the same as the others.” Three — as had been publicly declared — were Rodnik communications satellites. The fourth, though, was something quite else. Officially it was classified on the Pentagon’s public space database as orbital junk. But then it began to manoeuvre. “It moved away from the others,” says Christy. “And then we watched it put itself on a trajectory to catch up again with the rocket booster that launched it. It was some kind of test.”

What exactly Norad 39765 — known also as Kosmos 2499 and Object 2014-28e — is has still not been publicly declared. The Russians do not even acknowledge its existence. But the activities of the mystery “ghost” satellite have given many in the defence and intelligence community pause for thought. “In the last year, the Russians, China and the US have all been testing these kinds of things,” says Christy. “People talk about them being inspectors, but if you have the ability to manoeuvre up to another satellite in space to inspect it, you also have the ability to destroy it.”

Indeed, as far as several seasoned analysts, intelligence officials and diplomats spoken to by the Financial Times are concerned, 39765 best makes sense in the context of one of Russia’s most secretive cold war ventures — a programme that is now being revived: Istrebitel Sputnikov. The satellite killer.

Space, military officials like to say, is the ultimate higher ground. Since the cold war ended, however, it has been a largely uncontested territory. In January 1967, the US, UK and USSR became the first signatories to the Outer Space Treaty. In it, they committed to keeping the moon free of military testing and not putting weapons of mass destruction into orbit. China joined the pact in 1984. Another 100 states are now signed up.



Bob Christy (right) and Derek Slater of Kettering Grammar School tracking Soviet spacecraft Soyuz 11, June 6 1971

As a result, for three decades, space powers have been able to operate their own satellites with impunity. According to the Union of Concerned Scientists, there are at least 1,300 satellites now orbiting the Earth. Some have military purposes. Some are for civilian and commercial use. Most — 549 — are American. European powers are big players too. Russia has 131, the UK 40. But growing numbers are from rising countries. China now has 142 in orbit, India 33.

“ I don’t think there is a single G7 nation that isn’t now looking at space security as one of its highest military priorities and areas of strategic concern ”

With all this activity, the *pax caelestis* is unlikely to hold for much longer. Sixty years after the space race began, an orbital arms race is again in development.

Military officials from the US, Europe and Asia spoken to by the Financial Times confirm in private what the Kettering Group and other amateur stargazers have been watching publicly. Almost every country

- Senior European intelligence official

with strategically important satellite constellations and its own launch facilities is considering how to defend — and weaponise — their extraterrestrial assets. “I don’t think there is a single G7 nation that isn’t now looking at space security as one of its highest military priorities and areas of strategic concern,” says one senior European intelligence official.

“The threat is increasing and this is a major concern,” says Frank Rose, US assistant secretary of state for arms control. “Both Russia and China are developing ASAT [anti-satellite weapon] capabilities to hold US systems at risk. Now, we don’t believe it’s in anyone’s interest to engage in a space arms race . . . We don’t want conflict in outer space. But be assured, we will be able to operate in a degraded space environment. We’ve made it clear that we will do what is necessary to protect the space assets of the US and our allies against potential attack.”

Satellites are fragile things: a nudge to their orbit, a tilt of their solar panels towards the sun, a laser blast directed at their sensors or a projectile casually fired into their path are all capable of wreaking permanent, irreversible damage. “We have plenty of vulnerabilities we need to work on and space is one of the most important,” says General Denis Mercier, Nato’s supreme commander, who is charged with adapting the alliance to deal with future threats. “It’s a domain that is going to be as important in modern warfare as any other. We have a responsibility and a necessity to work on it.”



Space, says Mercier, needs to be considered in the same breath as sea and air when it comes to defence. While developed societies are becoming more dependent on it than ever before for almost every aspect of their digital economies, their grip on the technologies that have given them global strategic dominance is slipping. And as more countries around the world look to maximise their military advantages, space is becoming the most obvious domain to contest.

“This is going to explode in the very near future . . . you already have 60-plus nations who are interested in space capabilities,” says Elizabeth Quintana, senior research fellow at the military think-tank Rusi. “And with that, there are a number that are developing very serious anti-space capabilities, most notably China and Russia. When you think that western militaries and societies are critically dependent on space, it is an area to be seriously concerned about.”

Everything that gives modern western forces their technological and tactical edge over rivals, notes Quintana, stems from space-based systems. These include precision weaponry, drone surveillance and sophisticated real-time battlefield communications. “Even our tanks,” one British military officer says, “depend on our satellites.”

The Reaper drones that destroyed al-Qaeda’s leadership would have been useless without satellites; the intelligence on Russian troop movements around Ukraine came from them; and the smart bombs that reduced Saddam Hussein’s military to rubble in 48 hours wouldn’t have hit their targets if they hadn’t been there. Even Barack Obama’s phone calls rely on a specific array of them — the Advanced Extremely High Frequency constellation.

But it is not just a military issue. “Space, cyber, hybrid warfare . . . they raise questions of our resilience,” says Mercier. And resilience, he adds, is something that societies, not just armies, need to address.

Western intelligence officials can reel off their concerns over what the loss of satellite communications could mean. There are all the things we currently depend on — from the navigation of aeroplanes to our ability to make phone calls. And then there are the things we are becoming ever more dependent on — driverless cars or internet-linked domestic appliances.

“In the US, for the military — particularly the air force and Darpa [Defence Advanced Research Projects Agency] — the National Security Agency and the state department, this is now a key area of concern,” says Anthony Cordesman, former Pentagon intelligence chief and now chair of strategy at the think-tank CSIS in Washington. “But the challenge in space is going to affect virtually every aspect of the country’s strategy . . . the absolutely critical point is that in a world where geoeconomics are as important as geopolitics and strategy, we need to worry about the spectrum of vulnerability. It is not just military assets that [weaponising] space is a problem for, but our entire societies.”

Almost every cutting-edge technology being adopted in highly developed economies increases their dependency on undefended satellites. According to one senior British government official, the UK’s intelligence assessment is that 67 per cent of the country’s economy is dependent in some way on space-based communications. A report produced for the US Department of Homeland Security in June estimated that at least \$1.6tn of business revenues in America were “heavily influenced” by satellites.

“Space,” says assistant secretary Rose, “is vital to just about everything we do here on Earth.”

The original satellite killer programme was the brainchild of Vladimir Chelomey, the Soviet Union’s chief designer of aviation equipment. In 1960, the Soviets shot down an American spy plane, prompting Washington to reconsider its intelligence-gathering strategy. As the US turned to space, Moscow needed a means to stop it conducting its surveillance unimpeded.



TIROS 1, the US’s first weather satellite, undergoing vibration testing at RCA in New Jersey, before its launch on April 1 1960

“Right now, a lot of the activities we are seeing are exploiting the grey areas . . . So maybe we'll see an accidental collision. Or something being “misplaced” in orbit ”

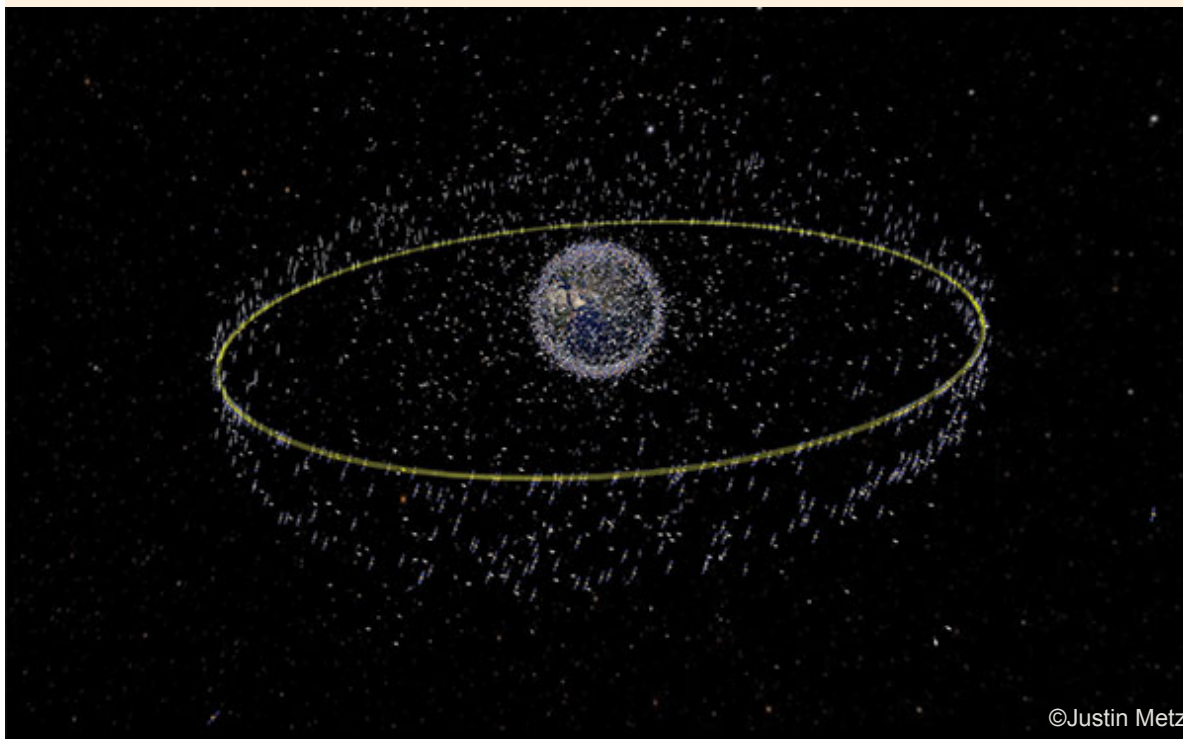
- Elizabeth Quintana, senior research fellow at Rusi

By 1967, Russia's programme was on a firm footing. A special directorate was formed within the general staff with responsibility for “space defence”. Russia performed its first fully functional anti-satellite weapon or ASAT test that year, launching a manoeuvrable payload into orbit where they used it to trial an attack. The principle was simple enough: a nimble, light kill-vehicle, capable of firing a heavy, non-explosive projectile at a designated object in space, and destroying it.

Over the next decade, 15 more ASAT payloads would be launched by the USSR. By the 1970s, the Russians were ramping up their testing further. They even sent special armoured satellites, loaded with sensors to measure shrapnel damage, into space to act as targets for their anti-satellite weapons.

For its part, the US spent the 1950s, 1960s and 1970s primarily focusing on ballistic missile technology. Systems were developed that were primarily designed to hit other rockets — but some had the capability to reach into space as well. In 1959, a Bold Orion missile was launched from a B-47 Stratojet but only made it within four miles of its satellite target.

For the next decade, the US experimented with using nuclear weapons to wipe out enemy satellite arrays but the programme never captured the imagination of the Pentagon's military strategists. It wasn't until the 1980s, when CIA intelligence unveiled the extent of Russia's ASAT operations, that the US took the threat seriously. A programme rapidly developed a new generation of air-launched rockets that could strike targets in outer space. In 1985, the ASM-135 rocket was launched successfully for the first time from an F-15 jet to blow up Solwind P78-1. Three years later, the entire US ASAT programme was mothballed.



Telecoms satellites clustered in the orbit known as the geostationary ring at an altitude of about 36,000km, April 2008

As both Washington and Moscow became keen to curb the excesses of their prohibitive arms race,

Russia's ASAT programme had also begun to wither. Major General Anatoly Zavalishin, the head of Baikonur cosmodrome, recalled the death-knell for the ASAT programme in his 1999 memoir. He told Mikhail Gorbachev he could conduct all his tests in secret, without the Americans discovering their activities. The Soviet premier, the general recalled, gave a polite and "resolute" refusal.

It would not be until 20 years later that satellite killing came back on the agenda — put there by a whole new power.

On January 11 2007, 865km above the Chinese mainland, a weather satellite was blown to smithereens by an object blasted into space from Base-27, the Xichang spaceport. Debris was sent hurtling around the atmosphere. More than 2,300 pieces of golf ball size or larger — each lethal to anything it hit — were released into orbit, according to Nasa. At least a third will circle the Earth until 2035. "Have you seen the film *Gravity*?" asks Quintana, referring to the hurtling mass of spoilage from an accidental collision that spells the undoing of Sandra Bullock and George Clooney. "It's literally like that."

Some scientists have even posited the possibility of a lethal shrapnel chain reaction as a result of future ASAT detonations. The detritus from one explosion could spread out to hit other satellites, which in turn would fragment, and so on. Eventually much — if not all — of the world's critical satellite constellations would be inadvertently wiped out.

The Chinese insisted the project — known as SC-19 — was benign. "China will not participate in any kind of arms race in outer space," foreign ministry spokesperson Liu Jianchao told Reuters. But the effect on both Washington and Moscow was nevertheless electric.

In the US, the National Security Council castigated China almost immediately. In private, the Pentagon put its own ASAT capabilities back on the high-priority list and on February 20 2008, it authorised Operation Burnt Frost. The USS Lake Erie launched a missile at USA-193, a national reconnaissance office satellite. The test was a success. The satellite, Washington said, was defunct, and posed a risk of crashing to Earth. Informed observers noted, though, that USA-193 would probably have disintegrated on re-entry anyway. The cost of launching a ballistic missile to intercept it instead was \$100m.

Meanwhile, amid a broader plan to modernise the country's decaying military, Russian media began referring to the country's "latent" ASAT systems in 2009. In 2010, the plan to revive them was articulated. Oleg Ostapenko, the commander of Russia's space forces, told Itar-Tass, the news agency, that the military was developing a new generation of "inspection and strike" weapons. "Our policy is that there should be no war in space," he said. "But we are military people and we should be ready for everything."

China has gone on to push further and further with its efforts. In 2008, a highly manoeuvrable nano-satellite, the BX-1 — a 40cm cube — was positioned dangerously close to the International Space Station. Officially the BX-1 is for inspection and observation. But it also has potential as a weapon. Had it been directed to do so, it could have destroyed the space station and

killed the astronauts on board.

Then in 2013, China launched the Dong Neng — another ASAT interceptor. It currently has three ASAT-capable vehicles positioned in space.

Firing rockets into the outer atmosphere is not the only way to destroy things in space. “ASAT until recently has been entirely kinetic, but what we’re seeing a lot more of now is a cyber component to the approach,” says Patricia Lewis, research director at the international security department of Chatham House. “If you

can hack into a satellite’s control systems there are plenty of things you can do — turn the solar panels so they fry up in the sun, move the satellite into a destructive orbit, turn it into a weapon to smash other satellites with, or perhaps most insidious of all, you could just insert changes into the data it was transmitting back to Earth, so the operators would act on it and perhaps you could cause even more damage back on Earth that way.”

Launching a cyber attack on satellites has three key benefits. Most obviously, attacks do not have to result in an uncontrollable debris cloud in outer space. But perhaps more significantly, cyber is also far cheaper for would-be assailants and, if done well, it can be almost anonymous. This opens up a worrisome prospect for strategic planners — attacks that disrupt or spy on their countries’ infrastructure without the ability to respond and therefore without the prospect of deterrence.

Last September, hackers broke into the data system of the US federal weather satellite network, the National Oceanic and Atmospheric Administration. Information from the satellites is used in everything from daily weather reports to environmental emergency planning and ballistic missile flight navigation calculations. The control systems were protected, officials said, and no critical data were affected, but just two months before, US government inspectors warned in an official report that an NOAA satellite system breach “could have severe or catastrophic adverse effects”. According to two senior cyber security officials, the Chinese were responsible. But there has been no public US government response.

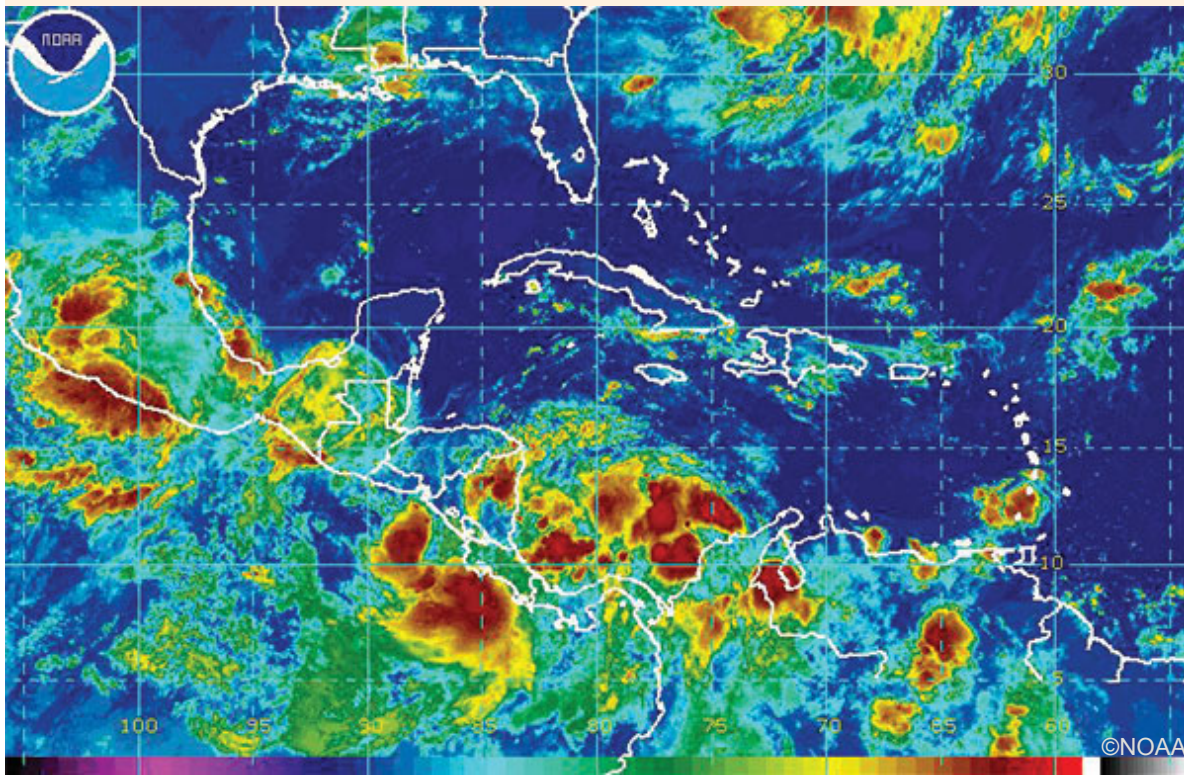
“Attacks on satellites,” says one US cyber security official, “are one of the fastest-growing areas of threat. The satellite network is like a great big open back door into almost every nationally important computer network or infrastructure out there.”

The US is spending billions improving its defences — primarily by building more capacity into its constellations and improving its tracking abilities. A \$900m contract was awarded to Lockheed Martin in 2014 to develop a radar system capable of tracking objects as small as baseballs in space in real time. But there are also hints that the US may be looking to equip its satellites with active defences and countermeasures of their own, such as jamming devices and the ability to evade interceptions.

A purely offensive anti-satellite programme is in fast development as well. High-energy weapons and manoeuvrable orbiters such as space planes all open the possibility of the US being able to rapidly weaponise the domain beyond the atmosphere, should it feel the need to do so.



A BX-1 observation satellite by China in 2008 was positioned ‘dangerously close’ to the International Space Station (above)



A NOAA satellite image of weather systems above Central America, August 13 2010; the network's data system was hacked in 2015

The 1967 Outer Space Treaty had one glaring omission: it has no limits on the use of conventional weapons. Even as militaries around the world work hard to build their space weaponry arsenals, many are now wondering whether the treaty needs to be broadened.

Just moments after President Obama's inauguration in 2009, the White House website was updated with a raft of new policy measures, including a desire for a comprehensive international ban on space weapons and anti-satellite technologies. It was a remarkable volte-face for Washington, which, angered by the Chinese test of 2007, was already racing to redevelop its space might.

Now, with Russian and Chinese test activity peaking, Washington has become increasingly hawkish. Efforts by the state department to try to secure some kind of diplomatic agreement have been paralleled by a fast-track military development programme. There is no way to stop the weaponisation of space, US military chiefs say, except by maintaining the US's overwhelming military superiority there. As relations with Moscow deteriorate, and friction between China and the US mounts over issues such as cyber espionage and the South China Sea, hopes of any kind of international treaty for space are fading fast.

“ The satellite network is like a great big open back door into almost every nationally important computer network or infrastructure out there ”

- US cyber security official

“You won't get the Pentagon to agree a treaty . . . but sooner or later Washington is going to have to realise something needs to be done,” says Lewis of Chatham House. “We are only increasing our dependence on space. The Pentagon is envisaging a world of single-country dominance, but these emerging technologies are equalisers. They reduce the gap and they make developed countries the most vulnerable . . . The state department know that. They know the US can't dominate and in the long run it's a losing battle. By fighting it, all that happens is you push others to develop their capabilities faster than they might otherwise.”

A tangle of diplomatic efforts hobbles on. In Vienna, the UN Committee

on the Peaceful Uses of Outer Space (Copuou) is negotiating a set of “long-term sustainability guidelines”, while in Geneva, the UN Conference on Disarmament is debating a proposal submitted jointly by Russia and China last year: the Treaty on the Prevention of Placement of Weapons in Outer Space (PPWT). In New York, the first and second committees of the UN General Assembly are jointly meeting — for the first time last month — to broadly tackle space security. A Russian resolution known as the “No First Placement” proposal (NFP) is currently under review.

There is significant opposition to all three. The Copuou proposal is too broad and outdated. The PPWT proposals are treated with scepticism by Washington and Europe because they ignore current existing ASAT capabilities, while the NFP rule has been dismissed as a Russian ruse. An international pledge for no first placement, one European diplomat joked, is the same thing as a Russian pledge for second placement.

Efforts are now turning on trying to strike some kind of agreement before any formal international accord. The EU has a proposal — but it is moving slowly. Discussions on a new “code of conduct” for space, proposed by the bloc, began in earnest in July.

“There is an urgent need for something cross-cutting and politically binding now,” says Jacek Bylica, the EU’s special envoy for non-proliferation and disarmament. “Negotiations on any treaty can carry on for decades — it has been decades since the last one was agreed. The problem we see too is that many of the initiatives at the moment are addressing the weaponisation of space in the future but not the real issue right now, which is existing anti-satellite technologies.

“What we are proposing is a set of traffic rules for space. It would be a political commitment . . . rules on principles for the operation of all objects in space. But we are facing considerable scepticism.”

The EU has its supporters elsewhere. Countries such as India and Brazil — both of which are increasingly dependent on civilian and commercial space activities for their economic development — want safeguards.

“We have to focus on the practical,” says US assistant secretary Rose. “We don’t like the PPWT. But we are prepared to work with [the Russians and the Chinese] when it’s in our mutual interests. We see a lot of merit in the EU [code of conduct] proposal, but they’ve had some challenges in the diplomacy there. There’s no silver bullet. But we need strategic restraint.”

As with any international effort at arms control, however, it may be that the only way to secure the consensus is for the threat to crystallise. Until a serious incident occurs, some rationalise, the chances of getting powerful militaries to start thinking about their limitations, rather than their capabilities, is slim.

“Whether someone would go for an in-space or missile attack, I don’t know,” says Quintana. “But right now in international conflicts, a lot of the activities we see are exploiting the grey areas. Incidents which are deniable, for example. So maybe we’ll see an accidental collision. Or something being ‘misplaced’ in orbit. Something that is an attack, but not something that anyone can necessarily respond directly to.”

“It might not be widely known about but it is critical,” says Bylica. “Our societies, our economies, they depend on this. For a long time our use of space was gradual — first it was for national security and then telecoms. But now everything uses it, from your GPS to your ATMs, to things you would

never suspect, like gas pipelines. It’s a spectrum. And we are very vulnerable.”

Sam Jones is the FT’s defence and security editor

Illustration by Justin Metz

Photographs: Alamy; US Mission Geneva; NOAA

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