ASATs and Space Weapons, A blast from the past?

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(Speaking Notes)

INTRO SLIDE

This initial slide is a view from the International Space Station. Just to orient you to the neighborhood, the ISS orbits at about 400 kilometers above the earth's surface, about the distance from Ottawa to Quebec City. Much of what we think is in space is really in the neighborhood.

Satellites provide information and other services that are increasingly critical for national security, economic vitality, and human well-being, their owners are increasingly concerned about keeping them safe—for as long as there have been satellites there have been plans for interfering with them. The act of destroying a satellite can damage the space environment by creating dangerous amounts of space debris. What's more, the impairment or loss of an important satellite, such as one used for reconnaissance, can quickly escalate a conflict or generate other unpredictable and dangerous consequences. And short of an actual attack on a satellite, even the targeting of satellites or the construction of space-based weapons could precipitate an arms race with its own damaging and far reaching consequences (including the diversion of economic and political resources from other pressing issues, or the hindrance of international cooperation necessary to make progress on important challenges such as nuclear non-proliferation, climate change, and terrorism).

SATELLITE ORBITS

About half of active satellites are in low-earth orbits, which are from around 200 km above the earth's surface to around 1500 km, which is where the Van Allen radiation belts starts making operations more challenging. A large portion of the rest are in geosynchronous orbits, around 36,000 km away (or about 5-6 earth radii away). There, they orbit at the same rate as the earth turns, so they appear stationary, so they're valuable for broadcast. The rest have specialized orbits, such as constellations for navigation and timing.

SATELLITE MAP

I was tasked with the talk title "ASATs and Space Weapons, A blast from the past" Because these issues have become salient at different times over the last 60 years and because they are once again nearing a critical juncture, I thought I would spend a few minutes just describing how this history.

The space environment has changed over the last fifty years, and it has changed especially rapidly over the last decade or two. For a large fraction of our history in space, space was

primarily the domain of two main actors, the United States and the Soviet Union who primarily used space for strategic national security purposes such as early warning of ballistic missile launch and intelligence support to verify arms control treaty compliance.

Both countries developed prototype anti-satellite weapons, weapons that would propel shrapnel from an explosion near a satellite, weapons that would ascend on a missile launched from an airplane and then collide with the satellite, ground-based laser weapons targeting the sensors and other vulnerable components of satellites. At the same time, both countries engaged in research and development of strategic missile defenses. Because intercontinental-range ballistic missiles reach similar speeds and altitudes as low-earth orbiting satellites, ballistic missile defenses can often be used equally well (or better) as anti-satellite weapons.

In the spring of 1983, President Ronald Reagan gave his "Star Wars" speech, announcing that he intended to focus U.S. resources on developing a large scale missile defense system. The Strategic Defense Initiative (SDI) he created was expected to develop several types of space-based interceptors that would have intrinsic ASAT capabilities. Though the systems that emerged from this program are mainly ground-based, small research projects dedicated to space-based missile defense still exist.

While there was interest in these technologies and projects embarked on, the overall story was one of mutual restraint. Both states understood that unconstrained weaponization of space would lead to an arms race and dangerous instabilities in the nuclear relationship. And the Anti-ballistic Missile Treaty strongly constrained strategic missile defense deployments.

MASTERING THE HIGH GROUND

In the early 2000s, the metaphor of mastering the "high ground" became a governing principle driving military thinking and planning for space. This was at least in part a response to the growing importance of space assets to the conduct of conventional military actions for a global power—providing the means for precision guided munitions, for intelligence surveillance and reconnaissance, and for global communications.

Plans for dominating space proliferated, and included proposals for ground-based weapons aimed at satellites and space-based weapons aimed at space and ground objects.

Ultimately, these plans foundered as they came up against technical and economic realities and because priorities shifted after the events of September 11 2001.

SATELLITE OWNERS

Today, many more actors are now in space, trying to use it to develop economically, to pursue scientific goals, and to support national security. This has created a complex ecosystem which can bring great benefits, but also creates competition. Space is not insulated from conflict on

earth, and it can unpredictably escalate crises on the ground or be the spark that starts one. character, too.

In the last decades, there have been numerous efforts aimed at getting a handle on these risks by negotiating agreed constraints. A history of this is beyond the scope of my talk, but because we have the honor of former ambassadors to the CD Peggy Mason and Paul Meyer on the panel, who've worked creatively and tirelessly to move this issue ahead, perhaps we can have some comment in the discussion.

In any case, international efforts did not lead to a substantive set of constraints either on space-based weapons or on anti-satellite weapons, nor on behavior.

SECRETARY WILSON

Within 24 hours of being sworn in this past May, Secretary of the Air Force Heather Wilson stated in testimony that "space is now a warfighting domain, similar to the more familiar air, land, and maritime domains our men and women are fighting in today". This reflects the shift in thinking in the US government away from the idea that space has a special character, as indeed is reflected in the Outer Space Treaty as a peaceful domain. And that the US has to work quickly to preserve its superiority in space. This is primarily due to the progress of other countries, particularly China, in establishing their own national security architectures in space as well as the proliferation of technologies useful for anti-satellite weapons.

Some of these technologies are expensive and sophisticated, but others are within the reach of less developed countries and could provide the ability to hold satellites at risk.

LASER DAZZLING

Directed energy weapons, such as lasers and microwave weapons, have a number of desirable features for an attacker. The beams reach their targets rapidly since they travel at the speed of light, and the delivered power can be tailored to produce temporary and reversible effects or permanent, debilitating damage. Directed energy weapons also have disadvantages relative to physical interceptors: they can only reach targets in their line of sight, unless relay mirrors are used, and simple shields of reflective, absorptive, or conductive material can be effective defenses.

Relatively low-powered lasers can be used to interfere with a satellite's sensors by coupling them with mirrors that focus the light and can track the satellites as they move across the sky

Lasers can dazzle imaging sensors, making it difficult to impossible for them to see an area on the ground, but without creating lasting damage. Or they could be used at higher powers, which could permanently damage sensors. . This is a relatively low-tech weapon and expected to be within reach of a wide range of actors, even sub-state actors.

A significantly more sophisticated system could be used to train high powers of energy onto a satellite's solar panels or bus to damage it. This is significantly more difficult to do. As laser power increases, the lasers become larger and more complicated, since they require large power supplies, cooling, and, in some cases, exhaust systems. Such systems are, I believe, detectable and could be part of a verifiable arms control regime.

MISSILE DEFENSES AS ASAT SLIDE

A significantly more problematic technology is hit-to-kill interceptors. These are ground-launched (though could be air-launched) missiles which target ballistic missiles during midcourse (as they travel up above the atmosphere) and destroy them with the force of impact. This technology has been demonstrated by the US and China against orbiting satellites, and the technology which has been demonstrated or within the reach of Russia, India, and Japan.

Because satellites and long-range ballistic missiles travel on similar paths through space with similar speeds, this technology can also be used to target satellites. In fact, it is actually easier to target satellites than ballistic missiles, since someone attacking a satellite can wait until conditions are optimal but ballistic missile launches come with little warning and may be accompanied by decoys and other countermeasures.

The data presented here is a sketch of the anti-satellite capability of the United States' missile defense system based on Aegis ships. These ships carry interceptors which are being gradually improved with respect to sensor capability and to speed. In 2008, the US used one such interceptor to destroy a failed NRO satellite at about 250 kilometers altitude, an altitude at which the resulting debris would rapidly be pulled out of orbit by the atmosphere.

The top table gives estimated burnout speeds for the two main variants of the SM-3 interceptors, Blocks I and II, as well as the altitude they could reach if launched straight up, so essentially the height ceiling at which they could be used against other satellites. The red line on the bottom graph is 600 km, the height limit for the Block I interceptor, and the green dashed line is the height limit for the conservative estimate for the Block II interceptor. The blue curve is the cumulative number of satellites (a few years ago!) with closest approach to earth at that altitude. So essentially these interceptors would be able to reach all of the low earth orbiting satellites. The SM-3 Block IIA interceptors are still under development, and it is not clear what the final procured numbers will be, but it is likely there will be several hundred of them to perhaps 5-600, and the 33 BMD capable ships will increase to perhaps 80, which can be deployed worldwide.

Because this system is based on technology that already exists and is deployed, and because it has been demonstrated both against satellites and against missiles, and because the numbers of interceptors are expected to be so large, I believe this system is going to be the greatest obstacle to any satisfactory set of limits on anti-satellite weapons. I believe it will also be an enormous

obstacle to further reductions in the numbers of nuclear weapons, a topic I believe that Amb. Peggy Mason will reflect on later in this panel.

Such kinetic energy destructions leave enormous amounts of debris on orbit, which can contribute to self-limiting behavior by states that are invested in keeping space working well into the future, though clearly under crisis conditions, this isn't clearly going to carry the day.

PROXIMITY OPERATIONS IN SPACE

The issue of persistent space debris that is inimical to the safe and secure use of space is one reason why actors are increasingly interested in holding satellites at risk using less destructive types of weapons. For example, satellites that can approach an adversary's satellite closely while both are on orbit. This approach can be at low speeds, and with sophisticated technology, an actor can approach a satellite without the target's cooperation. At sufficiently close ranges, other types of nondestructive methods to interfere with the target can be contemplated. Such as electromagnetic attacks, spray painting sensors, even setting the satellite spinning. This would produce less debris. It is to be noted that while the United States has a great lead in this technology, other states are pursuing it as well, including China and Russia. Close approach technology is also very much dual use; it can be used to repair satellites, for example.

This is an example of an either temporary or permanent, technically sophisticated, attack, which has some elements of stealth or unattributability.

Also, importantly, close approaches of this type are also observable behaviors, and therefore could be subject to verifiable limits.

SPACE BASED MISSILE DEFENSE

The Platonic ideal of "blasts from the past" must be space-based missile defense.

In the last few years, a group of missile defense and space weapons advocates in the US Congress have been trying to move the project of a space-based missile defense system forward both to defend against nuclear armed missiles, but also to defend against direct ascent ASAT weapons, of the type I just mentioned as essentially indistinguishable from ground-based missile defenses.

This animation by JPL shows the constellation of GPS navigation satellites; as the satellites become visible to North America, their lines of sight light up in purple. You need at least 24 satellites to have enough of them in view to make the system work. This illustrates the issue with space-basing weapons that require timeliness—you need many of them.

It has been more than thirty years since the denouement of Ronald Reagan's fanciful Star Wars concept and more than twenty since Brilliant Pebbles, its more limited but still space-based descendant, was cancelled. It's been fourteen years since the American Physical Society's (APS)

landmark analysis which concluded that a system of space-based interceptors "would require a fleet of a thousand or more orbiting satellites just to intercept a single missile" and that "deploying such a fleet would require a five- to tenfold increase in the United States' annual space-launch capabilities." And eight years since the Obama administration set aside the George W. Bush era plan to build a Space-based Test Bed.

It's been five years since the US National Academy of Sciences released its report on boost-phase missile defense which stated that an "austere" capability of 600 or so interceptors would cost $300 billion and that space-based missile defense will be at least 10 times as expensive as any other option.

Besides the fact that a great many interceptors would be necessary and would be enormously costly, space-based missile defenses are vulnerable to being overwhelmed or defeated.

Unfortunately, members of Congress haven't seemed to have learned the lesson, and in this new study they will force the Pentagon to go back again to get the same answers that we already know. The Ballistic Missile Defense Review is being undertaken as we speak, and it includes at high levels policymakers who have long been partisans of space-based missile defense.

This issue is of the greatest concern to me today. Although it is unlikely that a full constellation would be built, there will be an effort to stage a test bed of a few interceptors. While the flaws of space-based missile defense will not be resolved with research and development, it's important to note that even a "test bed" project would be destabilizing internationally. Space-based interceptors are inherently anti-satellite weapons. Putting prototype interceptors in space would be viewed by adversaries and allies alike as putting the first dedicated space weapons in orbit. It would likely encourage development of similar technologies or other types of anti-satellite weapons by others.

FINAL SLIDE

As we celebrate 60 years of Pugwash conferences and 50 years of the Outer Space Treaty, I would note that this is once again an inflection point in space security. Technology is rapidly advancing and we do not have a straightforward Cold War strategic situation that drove the negotiation of a comprehensive arms control treaty like the OST

There are very good arguments for why negotiated limits would improve security, including lowering risks of crisis escalation, enhancing stability and the usability of space, and protecting the space environment for the generations to come. I think the United States and other countries will recognize that even with huge technical and economic advantages, one cannot remain protected from a determined adversary in space. Security and sustainability will need to be built cooperatively.