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SPACE-NUCLEAR NEXUS: CHALLENGES AND RISKS

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(Views expressed in the brief are those of the author, and do not represent those of ISSI)

Introduction

Today space assets are indispensable to the functioning of nuclear deterrence architectures around the world. Space assets play a vital role in nuclear deterrence dynamics by providing early warning, communication, intelligence, and navigation capabilities. They also provide critical capabilities that enable nations to monitor, communicate, and respond to potential nuclear threats. This means that space capabilities are integral to the nuclear deterrence architecture. Identifying the parameters of the space-nuclear nexus and its implications for nuclear deterrence and strategic stability is imperative.

Space-Nuclear linkage

Today, space capabilities are essential to nuclear deterrence and missile defence systems. These include providing essential support to Early Warning Systems; Nuclear Command, Control, and Communication (NC3); and Intelligence, Surveillance, and Reconnaissance (ISR).

Early Warning Systems

Space-based capabilities are integral to missile defence systems. Satellite-based infrared sensors help detect missile launches, providing early warning which decision-makers can assess and potentially launch interceptors. Space systems also work with ground-based radar systems to

provide early warning. Thus, early-warning satellites play a vital role in missile defence systems that depend on real-time detection of missile launches. The U.S., Russia, and China all have early-warning satellites.

Nuclear Command, Control, and Communications

Communication satellites provide secure communication between leadership, military commanders, and nuclear forces. In times of crisis, secure, timely communication along the chain of command is important, ensuring secure and seamless communication. Navigation satellites also play a vital role in NC3 by providing precise timing and positioning information for the operation of nuclear forces, including ballistic missiles and submarines.

The U.S., China, and Russia use satellites for military satellite communications (satcom) for nuclear and non-nuclear military operations. Satellite strategic communications play an important role by relaying messages within a state's nuclear command chain. The U.S. "publicly acknowledges that it uses specific space systems for transmission of presidential orders to launch nuclear weapons."[1] Reportedly, the Russian strategic communications system also relies on satellites to authorize nuclear weapon use.[2]

Intelligence, Surveillance, and Reconnaissance

Reconnaissance satellites are important for collecting information on adversaries' nuclear capabilities, deployments, and activities. The ISR is crucial for assessing threats and making informed strategic decisions. "ISR satellites enable the collection of information on rival states' nuclear facilities, capabilities, and related observable activities, and thus also facilitate counterforce targeting (i.e. directing nuclear weapons against military targets such as the adversary's nuclear forces and NC3 systems)."[3]

Space-based ISR capabilities are increasingly important with the advent of precision-strike weapons. These weapons depend on accurate real-time information on targets. Some analyses have asserted that "nuclear deterrence relationships are being revolutionized particularly through the deployment of constellations of surveillance satellites equipped with synthetic-aperture radars (SARs). SARs

1 Nivedita Raju and Tytti Erästö, "The Role of Space Systems in Nuclear Deterrence," SIPRI background paper September 2023, https://www.sipri.org/sites/default/files/2023-10/the_role_of_space_systems_in_nuclear_deterrence.pdf.
2 Ibid.
3 Raju and Erästö, "The Role of Space Systems in Nuclear Deterrence."

equipped with new data processing techniques may facilitate precision strikes against mobile missile launchers that were traditionally considered highly likely to survive nuclear counterforce attacks."[4]

Dangers of Space-Nuclear Nexus

The major power contestation is increasingly playing out in space, which some have called the fourth medium of warfare after, land, air, and sea. Increasing militarization and weaponization of space[5] is problematic for space assets but also has a direct linkage with nuclear deterrence as well. The U.S., Russia, and China have integrated space systems into their nuclear deterrence architecture. Other countries like India also have over two dozen dedicated military satellites that provide support to its conventional and nuclear forces. The interlinked age of space and nuclear assets poses the danger of escalation. Any offensive moves targeting space systems may create pathways to nuclear escalation.

Many states have counter space and Anti-satellite Capabilities (ASAT) including the U.S. and Russia. China conducted an ASAT test in 2007 while India tested in 2019.[6] Space systems are vulnerable to attacks through counter space capabilities both co-orbital and direct-ascent ASAT weapons, as well as directed-energy weapons, electronic interference, and cyber-attacks. Activities that harm space assets can also affect nuclear deterrence and are potentially escalatory.

Any attack or incapacitation of early warning systems, command, control, and communication systems can have an escalatory effect as these systems play a vital role in nuclear deterrence. Some analyses assert that major powers like Russia and the U.S have red lines with regard to these systems. In the case of the U.S. and Russia, attacks on these systems, and even interference would be considered escalatory, potentially triggering a response. Moreover, there is ambiguity vis-à-vis red lines of these three countries as to what actions in space would be considered escalatory.[7] Further, "these fuzzy red lines are blurred by the many uncertainties in space operations, such as congestion of orbits, considerations of potential civilian harm, the role of commercial actors in space, and the integration of artificial intelligence into space systems."[8] Integration of AI into space systems can also be problematic. While AI has a role in shortening time frames to process data from ISR, it also means that decision-makers have less time to respond with greater potential for

4 Ibid.

5 For details on space weaponization see Ghazala Yasmin Jalil, "Weaponization of the Final Frontier: Security Challenges and Prospects of Regulations," *CISS Insight* 11, No. 2 (Winter 2023): 52-66, https://www.journal.ciss.org.pk/index.php/ciss-insight/article/view/319.

6 "Mission Shakti: Space Debris Warning after India Destroys Satellite," *BBC News*, March 28, 2019, https://www.bbc.com/news/world-asia-india-47729568.

7 Nivedita Raju and Wilfred Wan, "Escalation Risks at the Space-Nuclear Nexus," SIPRI Research Policy Paper February 2024, https://www.sipri.org/sites/default/files/2024-02/2402_rpp_space-nuclear_nexus.pdf.

8 Raju and Erästö, "The Role of Space Systems in Nuclear Deterrence."

miscalculation. Also, actions taken in space, such as jamming or cyber-attacks on satellites, may have cascading effects that are difficult to predict. Thus, unintended consequences can escalate conflicts in ways that were not initially anticipated.

The space-nuclear linkage brings greater crisis instability. The vulnerability of space-based systems for NC3 creates vulnerabilities that adversaries might exploit during a crisis. Any disruption or perceived threat to these systems could lead to rapid escalation, with decision-makers feeling pressured to act before losing their capabilities.

Space-Nuclear Nexus and South Asia

While Pakistan has a modest space program that is geared towards civilian use, India has a space program with civil, dual-use, and dedicated military satellites. In addition, India has ASAT capability that can potentially target Pakistan's space assets. South Asia is already a volatile nuclear theatre; the space-nuclear nexus further increases the potential for escalation.

India has Space-Based Surveillance (SBS) program since 2001 with at least 10 Cartosat and Risat series satellites operational with ambitions to place another 52 surveillance and communication satellites in the coming years to reduce reliance on countries like the U.S. and Israel. Once functional, the SBS-III will significantly augment India's space-based surveillance capability.[9] "The new spy satellites, equipped with AI, will enable India's surveillance capabilities to collect round-the-clock intelligence on adversaries' military installations and their force disposition….will enable New Delhi to track and detect their moving assets including naval warships and mobile missile launchers. Therefore, the new satellite constellation will make it challenging to conceal military installations and assets from these new sensors."

This affords India an advantage in ISR capabilities against adversary's military and nuclear forces. It can also potentially harm the adversary's satellites through its ASAT capability. Space-based capabilities also give India an advantage in precision strike weapons. All these capabilities constitute a cause of concern for Pakistan and are essentially destabilizing for South Asia.

Space Regulations

Space is a comparatively unregulated domain. While there is a non-proliferation regime that provides some checks and balances on the development and use of nuclear weapons, it is increasingly under strain due to accentuating major power rivalry. It is ill-equipped to deal with the

9 Usman Haider, "India's New Space-Based Spy Network," *The Diplomat*, January 22, 2025, https://thediplomat.com/2025/01/indias-new-space-based-spy-network/.

challenges posed by emerging technologies that have further strained nuclear deterrence relations. The space-nuclear nexus has further complicated nuclear deterrence dynamics with the potential for escalation.

There has not been any substantial development in regulating space weapons for decades. Treaties like the Outer Space Treaty of 1967 ban nuclear weapons in outer space; the Moon Agreement which bans any military activities on the moon or from the moon against other celestial bodies provide a basic regulatory framework. However, they lack universal adherence and are ill-equipped to deal with current challenges of weaponization of outer space. Initiatives like Prevention of an Arms Race in Outer Space (PAROS) sponsored by Russia and China have been deadlocked in the Conference on Disarmament (CD) since the 1980s due to the U.S. aversion to negotiating a legally binding instrument. Since April 2022 the U.S. has imposed a unilateral ban on ASAT testing, supported by a number of countries. However, China and Russia have rejected it. While the U.S. is interested in negotiating a ban on ASAT, Russia and China advocate a ban on all weapons. Thus, any progress on space weapons regulation has remained deadlocked due to political differences.

The emerging space-nuclear nexus and the associated dangers of escalation and crisis instability make it imperative that states recognize the dangers and work on measures to mitigate them. A combination of confidence-building measures, strengthened international norms, incremental agreements, and enhanced verification mechanisms can help mitigate the dangers of space-nuclear nexus and promote a more secure and stable space environment.

Conclusion

The space-nuclear weapons nexus represents a complex and evolving challenge for global security. The militarization of space introduces new dimensions to warfare, where actions in space can have severe consequences for nuclear deterrence. Space-nuclear weapons nexus is characterized by ambiguous red-lines, increasing the risk of miscalculations, unintended conflicts, and potential nuclear use. Addressing the issue requires a multifaceted approach, including the strengthening of international legal frameworks, the promotion of transparency and confidence-building measures, and the prioritization of peaceful cooperation over competition. Today, it is imperative that nations work together to preserve peaceful use of space which is the global commons, and prevent the escalation of conflicts that could have catastrophic consequences for humanity.