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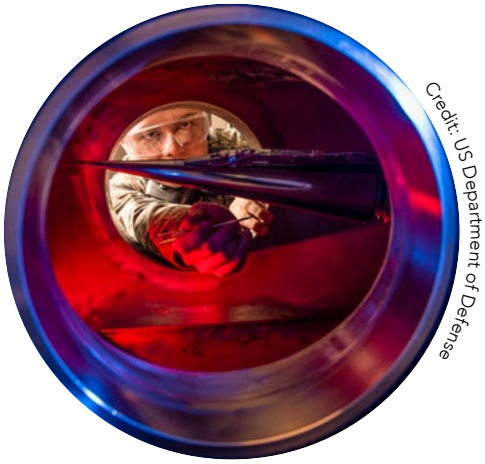
Emerging technology snapshot

Countermeasures against Hypersonic Weapons

Hypersonic weapons (including cruise missiles, glide and boost-glide vehicles) travel at Mach 5 or higher, retain a degree of in-flight maneuverability and follow lower-altitude, difficult-to-track trajectories, all of which make intercepting these weapons much harder than with ballistic missiles. Research on countermeasures to hypersonic weapons include high-power lasers and microwave weapons, railguns and hypersonic interceptors, along with 'soft-kill' weapons like cyberattacks to confuse, overload or disable critical subsystems, such as receivers for satellite navigation signals or controllers for flight surfaces.



Credit: US Department of Defense

Enabling Science and Technology

High-power lasers

High-power lasers can be used to disable a hypersonic weapon through a direct hit, by heating and disrupting the high-speed airflows (boundary layers) around the vehicle, as well as by blinding (or 'dazzling') sensors used to navigate towards its target.

Satellite imaging and navigation

Due to their high speed and low-altitude trajectories, satellite imaging (including optical, microwave or radar sensing) is critical to early launch detection and ongoing tracking of hypersonic weapons in flight. Reliance on global navigation satellite systems (GNSS) can also be used against a hypersonic weapon by 'spoofing' fake GNSS signals that falsely tell it that it is headed the wrong way.

Artificial Intelligence (AI)

AI is a key emerging technology in hypersonic weapon countermeasures, being used for tasks including detecting a weapon's launch, running simulations to recommend the best countermeasure(s), determining the best intercept path and controlling interception of the hypersonic weapon with the countermeasure(s).

Cyber-based countermeasures

Targeted cyberattacks (like Distributed Denial-of-Service (DDoS) attacks) can exploit weaknesses in the software controlling a hypersonic vehicle's flight or navigation so as to confuse, overload or otherwise shut-down these systems while a weapon is on route to its target. Cyberattacks can also be used to disable supporting infrastructure, such as land-, sea- or air-based launch platforms.

Decision support systems

The speed of hypersonic weapons greatly reduces the time available to assess a situation, consider options and deploy countermeasure(s). Decision support systems provide a single system that combines a priori information, established decision frameworks and real-time data to assess threats and choose the best countermeasure(s).

"People think of hypersonics as a thing … [but] it's a capability to deliver a wide range of effects to the battlefield to allow defeat of deep inland targets … maritime targets, costal targets, heavily defended targets, and targets on the move."

Mike White, Principal Director for Hypersonics, Office of the Undersecretary of Defense for Research & Engineering. Hypersonic Strike & Defense: A Conversation with Mike White, June 2, 2021

Signals

Academic

Research into countermeasures against hypersonic weapons is dominated by Chinese and American organizations, which respectively account for 51% and 21% of papers published between 2017 and 2022. Canada is ranked 11th with 44 publications during this period.

Government

National governments support research into hypersonic weapon countermeasures either directly through military research (e.g., USA) or indirectly via research and development (R&D) funding (e.g., Canada, Europe).

Collaboration

European research into hypersonic weapon countermeasures is largely organized through Research and Technology Organizations (e.g., France's CNRS) that help co-ordinate research efforts.

Defence

Defence-related organizations are heavily involved with research in hypersonic weapons and countermeasures. According to publicly-available information, the US Air Force (USAF), Navy and Missile Defense Agency (MDA) are among the largest funding bodies supporting this research.

Corporate

Industrial research into hypersonic weapon countermeasures tend to be by large US-based military contractors (e.g., Lockheed Martin), but Ottawa's ATA Engineering has also received USAF and MDA research funding.

"I do not have a 300-kilowatt laser today. … I can tell you that if we can persist for 5-6 years, we can have that laser. … If we persist a few [more] years, I can have the laser that goes on an Army combat vehicle."

Dr. Michael Griffin, Under Secretary of Defense for Research & Engineering. US Senate Armed Services Committee on Accelerating New Technologies to Meet Emerging Threats, April 18, 2018.

Impact

Social

The Department of Defense (DoD) set up a Joint Hypersonics Transition Office (JHTO) in 2020, whose tasks include developing a skilled workforce to support future hypersonic R&D through a university consortium.

Policy

Neither hypersonic weapons nor their countermeasures are covered by existing Arms Control treaties on ballistic missiles, and it is uncertain whether future arms control agreements will include these weapons.

Economic

Funding for hypersonic offence far exceeds that for hypersonic defense: a congressional report noted that the DoD requested $4.7 billion for hypersonic weapons programs in Fiscal Year 2023, but only $225.5 million for hypersonic defense programs during the same period.

Environmental

Satisfying the energy needs of directed-energy countermeasures (e.g., high-power lasers) could also spur improvements in high-capacity, grid-level battery storage for renewable power.

Defence

The need to counter hypersonic weapons may shift the US' approach to strategic deterrence away from its large nuclear arsenal towards smaller-scale national or regional ballistic missile defence.

"I put it [hypersonics] in the same category as when we developed stealth capabilities … With stealth, our systems were invisible to radar. With hypersonics, our systems are perhaps visible, but they're harder to stop, and that's the advantage that they bring to the battlefield."

Dr. Mark Lewis, Director of Defense Research and Engineering for Modernization, "Department of Defense Press Briefing on Hypersonics." March 2, 2020.

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