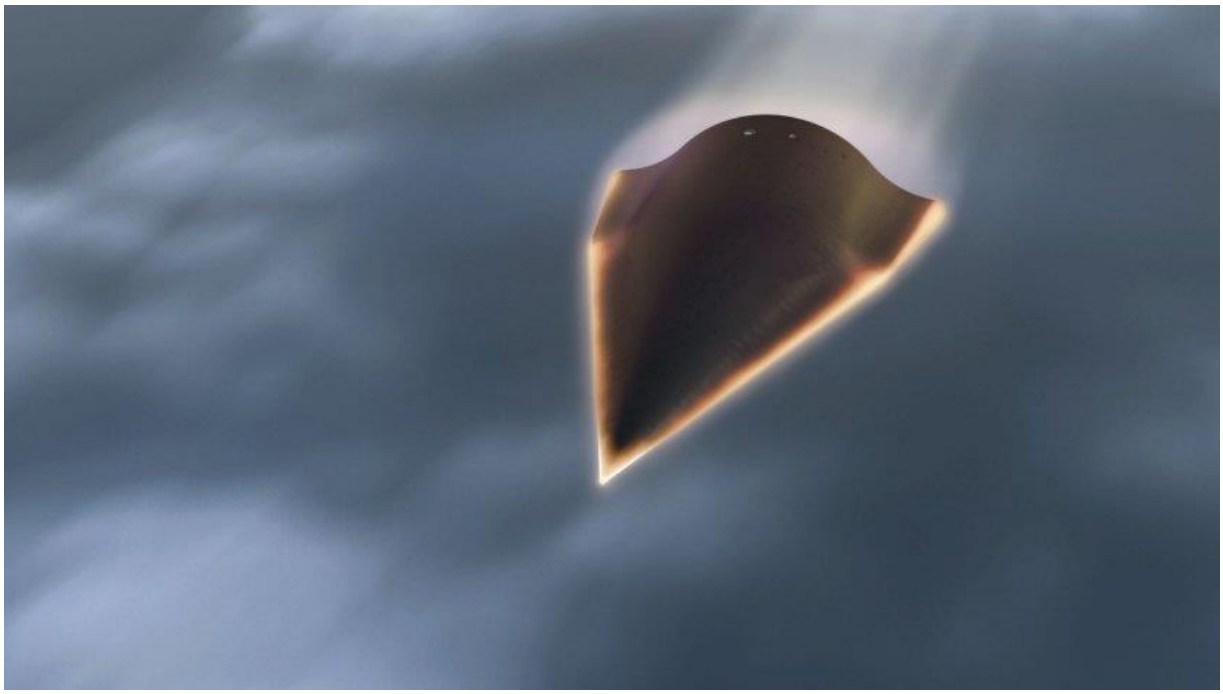
Prompt strike: ground-launched hypersonics move against missile defences

Armed forces are developing ground-launched hypersonics in response to rapidly emerging threats and modern ballistic missile defence systems. *Rahul Udoshi* and *Akshara Parakala* examine programmes in the United States, Russia, China, and India

Research and development (R&D) of hypersonic technology has led to high-speed weapons that, in turn, have been identified as a key area that militaries need to focus on to remain technologically relevant.

Over the past several decades significant technological development efforts were conducted in cycles resulting in one research campaign being used to improve follow-on activities. This process led to milestone advances in hypersonic weapon technology. For around two decades, developers were working towards primarily using hypersonic technology in the ballistic missiles weapon segment, boost-glide vehicles, and cruise missiles.



An artist's rendering of separated HSSW vehicle in flight. It is one of several hypersonic glide vehicles that have been developed as rapid delivery weapons. (DARPA)

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Significant efforts are being undertaken in fields such as modelling, wind-tunnel testing, nose cone design, smart materials, re-entry vehicle dynamics, and specific software applications. As a result, ground-launched hypersonics now promise high rates of readiness and reliability, and a high degree of accuracy, enabling militaries to attack a range of targets. Moreover, these systems could significantly weaken existing enemy missile defences.

US programmes

The US Department of Defense (DoD) and other US government agencies have a growing emphasis on developing hypersonic weapons that are expected to mature in the 2020s. This aligns with increased investment in resources for hypersonic research by the Pentagon.

The US Army Space and Missile Defense Command and Sandia National Laboratory are working on the Advanced Hypersonic Weapon (AHW), now known as the Alternate Re-Entry System. The weapon uses a hypersonic glide vehicle (HGV) to deliver a conventional warhead similar to the Defense Advanced Research Projects Agency/US Air Force (DARPA/USAF) Hypersonic Technology Vehicle-2 (HTV-2) concept. However, it could be deployed on a booster with a shorter range than HTV-2, which in turn could call for forward deployment, such as on the ground or at sea. It has a different design (conical, rather than the wedged-shape design of the HTV-2) and features a precision-guidance system for terminal attack.

The AHW's inaugural flight in November 2011 collected data that demonstrated hypersonic boost-glide technologies, thermal protection technologies, and test range performance. The glide vehicle, which was launched from the Pacific Missile Range Facility in Hawaii, travelled about 3,800 km before hitting a target.

The second flight test was conducted from the Kodiak Launch Complex off Alaska in April 2014, but controllers destroyed the weapon four seconds after launch when the external thermal protective cover, designed to regulate the motor's temperature, interfered with the launch vehicle steering assembly. A subsequent test was conducted using a scaled version from the Pacific Missile Range Facility in late October 2017. The scaled version was sized to fit on a submarine-launched ballistic missile.

The DoD requested USD86 million for the AHW in fiscal year 2016 (FY 2016), USD174 million in FY 2017, USD197.4 million in FY 2018, and USD263 million in FY 2019 to support planned flight tests in 2017 and 2019. The latest request, along with plans to advance the testing programme for the AHW, indicates that the DoD is moving towards development and deployment of a system using the AHW. However, the AHW programme is transitioning as part of the US Navy's R&D projects in FY 2020.

During FY 2019, the programme intends to focus on manufacturing and testing of the booster and hypersonic glide body that will be used in flight experiments; continue studies for future system development to examine cost, lethality, aerodynamic and thermal characteristics; and conduct trade studies to evaluate system alternatives, affordability, and end-to-end system concepts.

In parallel, DARPA is pursuing a High Speed Strike Weapon (HSSW) demonstration programme – a joint development with the USAF – which is driven by two main efforts: the Tactical Boost-Glide (TBG) programme being developed by Lockheed Martin and Raytheon, and the Hypersonic Air-breathing Weapon Concept (HAWC) programme led by Boeing. Initial capabilities are planned for air force (airborne) operational environments, and it would then transition to the navy (vertical-launch).

Although the DoD's primary goals for hypersonic development are air-launched weapons, DARPA in 2017 opened a new effort to develop and demonstrate a ground-launched hypersonic system integrating TBG technologies as part of a programme called Operational Fires.

The Pentagon's budget request for FY 2019 sought USD50 million to develop and demonstrate a ground-launched hypersonic system enabling hypersonic boost glide weapons to penetrate enemy air defences and rapidly and precisely engage time-sensitive targets. The goal is to develop an advanced booster capable of delivering a variety of payloads at several ranges; compatible mobile ground-launch platforms enabling integration with existing ground infrastructure; and specific system characteristics required for rapid deployment and redeployment.

In its FY 2019 budget request, DARPA requested USD179.5 million for continued TBG programme funding. The goal of TBG (and HAWC) is to accelerate a weapon to Mach 5 or greater and to enable it to glide to its target. Such weapons have to be highly heat-resistant, manoeuvrable, fly at altitudes of nearly 200,000 ft, and could feature a warhead in the 250 lb class, which is about the size of a Small Diameter Bomb (SDB). Ordnance and a guidance system are also under development via TBG and HAWC programmes.

Previously, the USAF and DARPA initiated a joint programme called FALCON (Force Application and Launch from CONtinental United States) as part of the Conventional Prompt Global Strike (CPGS) effort. This aimed to develop a launch vehicle similar to a ballistic missile and a hypersonic re-entry vehicle, known as the common aero vehicle (CAV), that could deliver warheads across the globe within one or two hours. The CAV is an unpowered, manoeuvrable HGV that has a delta-shape wing body design that can fly within the atmosphere at hypersonic speeds.

Lockheed Martin worked with DARPA on an early hypersonic vehicle effort, the HTV-2 concept, from 2003 to 2011. The Minotaur IV light rocket (renamed for the modified Minuteman and Peacekeeper missiles) was the booster for the vehicles, which were launched out of Vandenberg Air Force Base in California. HTV-2's inaugural flight in 2010 collected data that demonstrated advances in high lift-to-drag aerodynamics; high temperature materials; thermal protection systems; autonomous flight safety systems; and advanced guidance, navigation, and control for long-duration hypersonic flight. However, this programme was cancelled and efforts are now focused on the AHW.

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(1008 of 3493 words)

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