ANALYSING THE US HYPERSONIC ENDEAVOUR

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The major nuclear powers are looking to develop and deploy new stand-off capabilities. New and emerging military capabilities, including hypersonic glide vehicles, scramjet cruise missiles, manoeuvring reentry vehicles, and orbital bombardment systems, are becoming a high-priority security imperative for states like China, Russia, and the US in their strategic doctrines. Hypersonic missiles can evade legacy missile defences and jeopardise critical infrastructure.[1] More importantly, Russia and China have demonstrated their hypersonic capabilities. China has been demonstrating hypersonic capabilities since 2014.[2] Russia, on the other hand, has already claimed to use the Kinzhal (Kh-47M2) hypersonic missiles in Ukraine.[3] While China and Russia are now reportedly moving ahead in terms of deploying hypersonic capabilities, the US is facing several difficulties in this domain.

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1. John Plumb, "Missile Defense Strategy, Policies, and Programs," Statement before the Senate Armed Services Committee, 117th Cong., 2nd sess., May 18, 2022. https://www.armed-services.senate.gov/imo/media/doc/ASD%20Plumb%20SASC%20SF%20Missile%20Defense%20Written%20Statement%20-%20May,18%202022_FINAL.pdf. Assessed on December 26, 2023.
2. Richard D Fisher Jr, "US Officials Confirm Sixth Chinese Hypersonic Manoeuvring Strike Vehicle Test" *Jane's Defence Weekly*, November 26, 2015, https://web.archive.org/web/20151129233721/https:/www.janes.com/article/56282/us-officials-confirm-sixth-chinese-hypersonic-manoeuvring-strike-vehicle-test. Accessed on December 26, 2023.
3. Andrew W. Reddie, "Why the Alarm Over Russia's Use of Hypersonic Missiles in Ukraine is Misplaced," *Bulletin of the Atomic Scientists*, March 31, 2023, https://thebulletin.org/2023/03/why-the-alarm-over-russias-use-of-hypersonic-missiles-in-ukraine-is-misplaced/. Accessed on December 26, 2023.

Hypersonic technologies are not new, and the research goes back to the early heydays of the Cold War when the US managed to fly the X-15, a manned hypersonic test aircraft.

As per the reports, the US Air Force has recently conducted test flights of its hypersonic missile programme, the AGM-183A Air-launched Rapid Response Weapon (ARRW). The US Air Force launched the ARRW programme in April 2018 and planned to achieve the initial operational deployment in 2022. However, in November 2023, after conducting two test flights in August and October 2023, the ARRW hypersonic programme was officially cancelled.[4]

Hypersonic technologies are not new, and the research goes back to the early heydays of the Cold War when the US managed to fly the X-15, a manned hypersonic test aircraft. However, the US found it difficult to keep the pace intact on hypersonic technologies over the years. In the meantime, Russia, and especially China, took advantage of American research available about hypersonic technologies in the public domain and accelerated their efforts to develop and deploy hypersonic weapons. This article attempts to analyse and explain the hypersonic programme of the US its rationale, achievements and the current headwinds.

UNDERSTANDING HYPERSONIC WEAPONS

There are certain fine lines of differences between what can be referred to as hypersonic and what cannot. Ballistic missiles such as Intercontinental Ballistic Missiles (ICBMs), spacecraft, and hypersonic projectiles all travel beyond the Mach 5 range; going beyond Mach 5 is generally considered to attain hypersonic capability. However, ICBMs and spacecraft are not truly in the hypersonic domain of their flight trajectory. Technically, hypersonic refers only to travel at speeds beyond Mach 5 'within the Earth's atmosphere.' Spacecraft and ICBMs spend most of their flight time in the outer atmosphere and only briefly fly beyond Mach 5 within

4. Shannon Bugos, "Test Failures Put Hypersonic Program in Doubt," Arms Control Association, November 2023, https://www.armscontrol.org/act/2023-11/news/test-failures-put-hypersonic-program-doubt. Accessed on December 26, 2023.

the Earth's atmosphere. Most importantly, hypersonic projectiles deal with the thermal effects almost throughout their flight trajectory. Another important criterion distinguishing hypersonic projectiles is their need for aerodynamic control surfaces, such as wings or tail fins, to glide and manoeuvre. Hypersonic projectiles need to fly within the Earth's atmosphere because the control surfaces need air to perform. Beyond these characteristics, there are certain other challenges which a hypersonic projectile faces. The first is overcoming the problem of heating and, hence, the need for appropriate thermal shielding. Since hypersonic projectiles fly beyond Mach 5 speed, the drag generates heat, reaching temperatures over 3,140 degrees Fahrenheit. Hypersonic projectiles need special materials to overcome the associated effects of rising temperatures. Secondly, hypersonic projectile designers need to factor in the consequence of the way the shock layer behaves when the projectiles cross the Mach 5 mark. More importantly, the understanding of the shock layer essentially helps in maintaining stability and performing manoeuvres. The third essential characteristic of a hypersonic weapon is its capability to communicate and receive radio signals for the purpose of targeting. A hypersonic projectile requires to have windows called 'radomes' through which radio signals can be emitted or received. Radomes are difficult to develop because they need significant thermal shielding while performing their task of communication.

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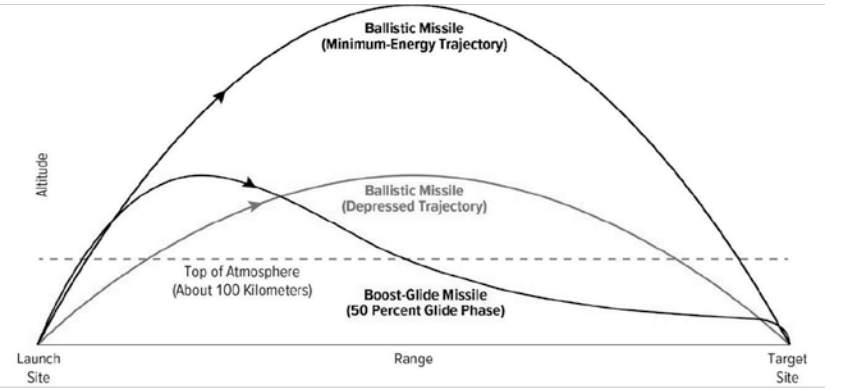
TYPES OF HYPERSONIC WEAPON SYSTEMS

The current hypersonic weapon systems can be divided into two categories:

- Hypersonic Glide Vehicles (HGVs).
- Hypersonic Cruise Missiles (HCMs).

The HGVs use rocket boosters for launch assistance and can, thus, reach speeds of Mach 20 or beyond. Once the HGV reaches its desired speed and momentum, the glider separates from the booster and flies unpowered towards the intended target. The HCMs, on the other hand, use a ramjet or scramjet engine, enabling the cruise missile to attain hypersonic speeds. Fig 1 shows the different flight trajectories of a ballistic missile and a boost-glide missile.

Fig 1



Source: https://www.cbo.gov/publication/58924. Accessed on December 8, 2023.

HISTORICAL BACKGROUND OF THE US HYPERSONIC RESEARCH (1959-2015)

The US test flew a piloted hypersonic aircraft called the X-15 from 1959 to 1968. This project helped the National Aeronautics and Space Agency (NASA) to develop piloted spacecraft. During this time, active research was conducted to understand the challenges associated with hypersonic flight. The current US Department of Defence's (DoD's) research programme on hypersonic boost-glide missiles goes back to the late 1970s when the Sandia Winged Energetic Reentry Vehicle Experiment (SWERVE) started the project and conducted three flights from 1979 to 1985.[5] The SWERVE

5. Kenneth W. Iliff and Mary F. Shafer, *A Comparison of Hypersonic Vehicle Flight and Prediction Results* (California: NASA Dryden Flight Research Centre, 1995), p. 7.

programme successfully tested a design for a missile glide body. Once the SWERVE programme ended, the space shuttle programme helped the US scientific community involved in hypersonic projects understand aerothermodynamics issues.

The second hypersonic missile research phase began in 2003 when the Defence Advanced Research Projects Agency (DARPA) started the Force Application and Launch From Continental United States (FALCON) project. The FALCON project was developed to launch a vehicle like a ballistic missile and a hypersonic reentry vehicle termed the Common Aero Vehicle (CAV). The rationale behind the FALCON project was to provide the US with the ability to perform the requirements of the prompt global strike mission.[6] The FALCON study was one the most detailed expressions of interest the US DoD indulged in regarding hypersonic technology. The study and the proposed CAV hypersonic vehicle paved the way for the Hypersonic Technology Vehicle (HTV). The HTV was initially the sole contender for the Conventional Prompt Global Strike Programme (CPGS). The HTV faced several difficulties in the initial test phases, and after the two prominent failed tests in 2010 and 2011, it was shelved. However, the FALCON study provided critical insights about the future US hypersonic programme and became instrumental in paving the way for the CPGS programme. Fundamentally, the FALCON study, while looking to develop the CAV, in a way, provided the following requirements for the CPGS:

- It indicated that the crucial role of speed, as in the case of the proposed CAV, should be around Mach 5. The centrality of speed was kept in mind so that a substantial payload could be delivered from the continental US to anywhere in the world within two hours to be able to get to time sensitive targets.
- The study specified 'time sensitivity' as an important factor while going for prompt missions. It stated that the CAV and its delivery vehicle should achieve alert status, which would make it ready to launch in under 24

6. Amy F. Woolf, "Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues," Congressional Research Service, July 16, 2021, pp. 10-11, https://sgp.fas.org/crs/nuke/R41464.pdf. Accessed on December 27, 2023.

hours and should then be able to launch from this alert status in less than two hours once it had received an execution order.

- Regarding manoeuvrability processing, the FALCON report argued that a CAV should have a cross-range capability of 3,000 nautical miles (nm). The study was clear that the ability to manoeuvre would determine how the CAV would come in contact with the mobile targets.
- Besides speed, alert status, and manoeuvrability, the FALCON study was important with regard to how the US DoD strategically viewed hypersonic weapons. The study was clear regarding segregating the hypersonic capability from the nuclear domain. In other words, the study focussed on the conventional payload capability of a hypersonic weapon.[7]

In 2008, US lawmakers established the CPGS programme which was instrumental in promoting concepts such as the HTV-2,[8] replacing some of the navy's nuclear-armed Trident missiles with conventional warheads, calling it the Conventional Trident Modification Programme (CTM). The idea behind the CTM programme was that though it would be a conventional missile with low payload capacity, it would also be a manoeuvrable missile with greater accuracy.[9] The CTM programme, however, got cancelled because of the fear that it may lead to an adversary perceiving or mistaking a conventional payload missile as a nuclear-tipped missile and responding with a nuclear attack. After the cancellation of the CTM programme and failed tests of the HTV-2, in 2012, the DoD started to look at short-range hypersonic missiles. The term 'global' was removed from the programme and it became the Conventional Prompt Strike (CPS) programme. During the initiation of the CPS, the US Army started its Advanced Hypersonic Programme (AHP). It was reported that in late 2011, a successful boost-glide weapon test was

7. Ibid.
8. For more information on the HTV-2, see "Falcon HTV-2", Defence Advanced Research Projects Agency, https://www.darpa.mil/about-us/timeline/falcon-htv-2.
9. Micah Zenko, "Conventional Weapons on Nuclear-Capable Delivery Systems," Council on Foreign Relations, 2010, https://www.jstor.org/stable/resrep05780.10?seq=1. Accessed on December 29, 2023.

conducted for the AHP. However, a second test for the same weapon in 2014 witnessed failure as the weapon blew up on the launch pad.[10]

Despite the cancellation or reduction in funding after the test failures, the hypersonic programme started in the early 2000s paved the way for contemporary US hypersonic ambitions in the following ways (Table 1).

Table 1

Original Programme	**Evolved Into**
The Advanced Hypersonic Weapon programme.	Common Hypersonic Glide Body (C-HGB) programme.
The Hypersonic Technology Vehicle-2	DARPA's Tactical Boost Glide Vehicle Further evolved into the current medium-range Air-Launched Rapid Response Weapon of the US Air Force.

THE RATIONALE BEHIND HYPERSONIC WEAPON SYSTEM DEVELOPMENT

There are multiple reasons behind the US' hypersonic weapon development programme. As mentioned earlier, this is not a new programme. The research for the weapon programme goes back to the Cold War days. However, the current renewed and intense interest in hypersonic weapon development needs to be understood from the point of view of the growing rivalry between the US and China and between the US and Russia, and the proliferation of emerging technologies. The following are the reasons behind the US' renewed interest in the hypersonic domain:

- **Changing Security Environment:** In the recent past, major strategic reports such as the Quadrennial Defence Review (QDR) Reports of 2001, 2006, 2010, and 2014, National Defence Strategy (NDS), Missile Defence Review (MDR)

10. Mark Gubrud, "Going Too Fast: Time to Ban Hypersonic Missile Tests? A US Response," *Bulletin of the Atomic Scientists*, 71(5), 2015, p. 2, https://journals.sagepub.com/doi/pdf/10.1177/0096340215599771#:~:text=Another%20program%2C%20the%20Advanced%20Hypersonic,pad%20(Wasserbly%2C%202014). Accessed on December 29, 2023.

The 2022 NDS referred to the changing security environment as "strategic challenges stemming from complex interactions between a rapidly changing global balance of military capabilities; emerging technologies; competitor doctrines that pose new threats to the threats to the US homeland and to strategic stability."

and Strategic Posture Commission (SPC) Report published by the US have mentioned the changing security environment. These reports have, at various levels, addressed the need for the US to have prompt, long-range strike capabilities. The 2001 QDR, which was published just days after the September 11, 2001, attacks on the US, advocated, "...deterring aggression and coercion by deploying forward the capacity to swiftly defeat attacks and impose severe penalties for aggression on an adversary's military capability and supporting infrastructure."[11] The 2006 QDR while referring to the Global War on Terror argued for the ability to "target enemy capabilities in denied areas."[12] This QDR argued for deploying a prompt global strike capability, using Trident submarine-based ballistic missiles armed with conventional warheads. The 2010 QDR also explored the question of future long-range strike capabilities with both penetration and stand-off weapons.[13] Most recently, the 2022 NDS referred to the changing security environment as "strategic challenges stemming from complex interactions between a rapidly changing global balance of military capabilities; emerging technologies; competitor doctrines that pose new threats to the threats to the US homeland and to strategic stability."[14] The 2022

11. Department of Defence, Quadrennial Defense Review Report, September 30, 2001, p. IV, https://history.defense.gov/Portals/70/Documents/quadrennial/QDR2001.pdf?ver=AFts7axkH2zWUHncRd8yUg%3D%3D. Accessed on March 28, 2024.
12. Department of Defence, Quadrennial Defense Review Report, February 6, 2006, p. 23, https://history.defense.gov/Portals/70/Documents/quadrennial/QDR2006.pdf?ver=2014-06-25-111017-150. Accessed on March 28, 2024.
13. Department of Defence, Quadrennial Defense Review Report, February 2010, p. 33, https://history.defense.gov/Portals/70/Documents/quadrennial/QDR2010.pdf?ver=vVJYRVwNdnGb_00ixF0UfQ%3d%3d. Accessed on March 28, 2024.
14. DoD, 2022 National Defense Strategy, p. 4, https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF#page=33. Accessed on January 5, 2024.

NDS categorically mentioned threats emanating from rapidly evolving technologies such as hypersonic weapons, among others.[15] In the same manner, the 2022 MDR argued about the changing security environment by referring to the evolving air and missile threat environment. The 2022 MDR downright argued that the US national security interests are at higher risk from wide-ranging missile arsenals which include hypersonic weapons as well.[16] The 2023 SPC report also recommended steps needed to improve the US' strategic posture on an urgent basis due to the rapidly changing security environment. The 2023 SPC report underlined the strategic threats emanating from Russia and China, including hypersonic defence programmes.[17]

Among other reasons, the rapid progression made by China and Russia in the Anti-Access/Area Denial (A2/AD) domain has made the US more serious about pursuing hypersonic programmes.

- **Regional Dominance and Assuring Allies:** In the early 2000s, when the DoD revived its hypersonic programme, the rationale was to counter any imminent threat from a potentially high-value terrorist organisation or unfriendly nation launching its nuclear weapons. However, over the years, as the hypersonic programme made some progress, additional elements have become part and parcel of why the US needs hypersonic capabilities. Among other reasons, the rapid progression made by China and Russia in the Anti-Access/Area Denial (A2/AD) domain has made the US more serious about pursuing hypersonic programmes.[18] More

15. Ibid., p. 6.
16. DoD, 2022 Missile Defense Review, p. 1, https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF#page=33. Accessed on January 5, 2024.
17. Madelyn R. Creedon, "America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States," Armed Service House, https://armedservices.house.gov/sites/republicans.armedservices.house.gov/files/Strategic-Posture-Committee-Report-Final.pdf. Accessed on January 8, 2024.
18. Michael Kofman, "It's Time to Talk About A2/AD: Rethinking the Russian Military Challenge," *War on the Rocks,* September 5, 2019, https://warontherocks.com/2019/09/its-time-to-talk-about-a2-ad-rethinking-the-russian-military-challenge/. Accessed on January 08, 2024. "China's Anti-Access Area Denial," Missile Defense Advocacy Alliance, August 24, 2018. Accessed on January 8, 2024.

importantly, the invasion of Ukraine by Russia and the increase in the threats of taking back Taiwan by China are making the regional allies of the US more worried. To counter such threats and bypass the A2/AD more effectively and efficiently in the Baltic and Pacific regions, the US would need a combination of speed, precision and lethality, which only a hypersonic weapon can provide.

- **Parallel Hypersonic Programmes:** The US DoD is mindful of the hypersonic developments of its adversaries, primarily, Russia and China. The 2023 Annual Report to the Congress about the Military and Security Developments involving the People's Republic of China (PRC), categorically mentioned how the deployment of the DF-17 HGV-armed Medium Range Ballistic Missile (MRMB) can strike US foreign military bases and fleets in the Western Pacific.[19] While China has deployed a hypersonic weapon, the more advanced hypersonic delivery systems such as HGV and Fractional Orbital Bombardment (FOB) systems are now becoming a major concern for the US. Since the PRC's HGV and FOB have been developed while keeping the nuclear weapons delivery system in mind, the US DoD sees this from a strategic point of reference. Russia's pursuit of hypersonic weapons has already been witnessed in the ongoing Russia-Ukraine War. President Vladimir Putin of Russia introduced three hypersonic weapons in 2018 and 2019, all capable of carrying conventional and nuclear payloads. The 2019 Missile Defence Review of the US recognised these hypersonic challenges from Russia to the US strategic interests.[20]
- **The Crisis of Arms Control Mechanisms**: It is a known fact that the US arsenals of missiles lack medium and intermediate-range ballistic missiles because of the Intermediate-Range Nuclear Forces (INF) Treaty. The INF Treaty prohibited the US and the erstwhile Soviet

19. US DoD, Military and Security Developments Involving the People's Republic of China 2023, https://media.defense.gov/2023/Oct/19/2003323409/-1/-1/1/2023-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA.PDF. Accessed on January 3, 2023.
20. DoD, Missile Defense Review 2019, https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.PDF. Accessed on January 3, 2024.

Union from developing or deploying ground-launched missiles with a range between 500 km to 5,500km. The treaty, however, did not specify any limit on air or sea-launched missiles of the same ranges. Despite this apparent gap in the treaty, the US did not pursue any missile programme of such ranges. The reasons were based on a variety of justifications arising from precision issues, cost, and no necessary strategic value towards nuclear deterrence. While being part of the treaty, the US became interested in the hypersonic programme, such as the hypersonic boost-glide missile, because of its flight path—a hypersonic weapon system uses less than half of the ballistic missile trajectory to reach to its target—which complied with the terms of the INF. The US withdrawal from the INF Treaty in 2019 further provided an impetus to counter the threats emanating from Russia and China. The US is now more interested in developing and deploying hypersonic weapons that have medium and intermediate ranges.

THE WELL-DEVELOPED HYPERSONIC MISSILE PROGRAMMES (2015-24)

The US DoD has been involved in multiple but separate hypersonic missile programmes being researched by the US Army, Air Force and Navy. The Future Years Defence Programme[21] (FYDP, more commonly pronounced as 'fye-dip'), which gives a projection of the forces, resources, and programme to support DoD operations over five years, estimated that the DoD for the 2023-27 period requested $13 billion for the sole purpose of developing hypersonic missiles and close to $2 billion for the procurement of missiles only.[22] The following sections describe the major hypersonic programmes, their specifications, funding and current status, being undertaken by the US Army, Air Force, and Navy.

21. For more information on the background and structure of the FYDP, see "Defense Primer: Future Years Defense Program (FYDP)," *In Focus,* https://crsreports.congress.gov/product/pdf/IF/IF10831. Accessed on January 1, 2024.
22. Corinne Kramer, "US Hypersonic Weapons and Alternatives," January 2023, p. 12, https://www.cbo.gov/publication/58924. Accessed on January 1, 2024.

The US Army's Long-Range Hypersonic Programme

Specification: The US Army's Long-Range Hypersonic Weapon (LRHW), also known as Dark Eagle, has a reported range of 1,725 miles. The weapon consists of ground-launched missiles with a hypersonic glide body. According to the US Army, the LRHW can travel well over 3,800 miles per hour. The LRHW can reach the top of the Earth's atmosphere and can remain beyond the range of air and missile defence systems. Lockheed Martin and Northrop Grumman have been developing the missile capabilities of the LRHW. The LRHW is called the Navy-Army All-Up Round plus Canister (AUR+C) when the hypersonic glide body is attached.[23]

The Common Hypersonic Glide Body (C-HGB) is based on the Alternate Reentry System. The C-HGB utilises a booster rocket to speed up above the hypersonic range and then jettisons the expended rocket booster. The C-HGB is being planned to be manoeuvrable to become hard to detect.

Rationale: The US Army's LRHW is developed from the point of view of being a strategic attack weapon. The fundamental rationale behind the LRHW is to counter US adversaries' A2/AD capabilities and to engage with critical targets.[24]

Funding: According to the Fiscal Year (FY) 2024 LRHW budgetary information, under the Research, Development, Test and Evaluation (RDT&E) category, the LRHW programme requested $944.355 million and under the procurement category, approximately $156.821 million.[25] In the

23. Andrew Feickert, "The U.S. Army's Long-Range Hypersonic Weapon (LRHW)", Congressional Research Service (CRS), 8 December 2023, https://crsreports.congress.gov/product/pdf/IF/IF11991#:~:text=LRHW%20is%20comprised%20of%20the,the%20Navy%2034.5%2Dinch%20booster.&text=Conventional%20Prompt%20Strike%20(CPS)%20system,both%20surface%20vessels%20and%20submarines.&text=The%20C%2DHGB%20is%20reportedly,Army%20and%20Sandia%20National%20Laboratories. Accessed on January 3, 2023.
24. DoD Fiscal Year (FY) 2020 Budget Estimates, *Army Justification Book of Research, Development, Test & Evaluation, Army RDT&E-Volume II, Budget Activity 4,* March 2019, p. 580, https://www.globalsecurity.org/military/library/budget/fy2020/army/rdte_ba4.pdf. Accessed on January 10, 2024.
25. Feickert, n.23.

same budget request, the army estimated that RDT&E would conclude in 2027 with a total cost of $5.3 billion.[26]

Status: Given the fact that hypersonic weapons are meant to be used in extreme conditions, extensive flight testing has to be done before they can be deployed. The LRHW programme was planned with an initial three test flights before the fielding of the first battery in FY2023. However, on October 21, 2021, the booster rocket toeing the C-HGB vehicle failed a test flight which was termed as a no-test. Then, in June 2022, the entire LRHW missile test failed. Not only the test failures, but the LRHW has also witnessed delays in flight tests. In October 2022, the DoD delayed a scheduled LRHW test to "assess the root cause of the June 2022 failure." On March 5, 2023, the LRHW test was again scrubbed due to undisclosed technical factors. The LRHW test was again halted in September 2023 and on September 14, 2023, the US Army acknowledged that the plan of deploying the LRHW in FY 2023 may not be possible.[27]

US Navy's Intermediate-Range Conventional Prompt Strike

Specification: The navy's boost-glide missile, which will carry the C-HGB, is a sea-launched missile called the Intermediate-Range Conventional Prompt Strike (IR-CPS). The exact specifications of the IR-CPS are classified. However, in terms of its range, the speculations suggest it would be about the same as that of the army's LRHW. Initially, the IR-CPS was planned to be deployed on the *Virginia* class nuclear-powered submarines, however, due to the shortage of time, the navy re-planned the deployment on the existing *Zumwalt* class destroyers and then planned to move on to the *Virginia* class submarines in the later phase.[28]

26. U.S. Hypersonic Weapons and Alternatives, Congressional Budget Office, January 31, 2023, p. 12.
27. Anthony Capaccio, "US Army Faces Facts: Its Hypersonic Weapon To Miss a Deadline," *Bloomberg*, September 15, 2023, https://www.bloomberg.com/news/articles/2023-09-14/us-army-faces-facts-its-hypersonic-weapon-will-miss-a-deadline. Accessed on January 12, 2024.
28. Zach Abdi, "US Navy Taps Lockheed Martin For More Conventional Prompt Strike Work," *Naval News*, August 28, 2023, https://www.navalnews.com/naval-news/2023/08/us-navy-taps-lockheed-martin-for-conventional-prompt-strike/. Accessed on January 12, 2024.

The IR-CPS programme has been funded by the navy since 2019. From 2019 to 2022, the navy received $2.6 billion for the programme. In 2023, the DoD requested $1.2 billion for the programme.

Rationale: The IR-CPS will cover missions seeking high-value but time-sensitive targets, and will primarily be deployed for penetrating air defences. More importantly, even though the IR-CPS is a conventional weapon, it is being prepared to cover strategic missions. When asked about the mission which IR-CPS will eventually serve, Johnny Wolfe, who is currently the director of the Strategic Systems Programme, stated "It's strategic, but it's not nuclear. If you look at the numbers, particularly with what we're going to have with the ranges, it is very much a strategic asset. You can hold very high-value targets at risk … and you can do that with all these various platforms."[29]

Funding: The IR-CPS programme has been funded by the navy since 2019. From 2019 to 2022, the navy received $2.6 billion for the programme. In 2023, the DoD requested $1.2 billion for the programme. On August 24, 2023, the navy awarded a modification contract to Lockheed Martin worth $315 million.[30] Lockheed Martin is the prime systems integrator for the navy's CPS and the army's LRHW systems.

Status: The IR-CPS, in the immediate future, will be deployed on three *Zumwalt* class destroyers and later on Block V *Virginia* class submarines. The first ship of the class, the USS *Zumwalt* (DDG-1000), is already undergoing a two-year modernisation drive.[31]

29. Mallory Shelbourne, Navy Planning for December 2025 Hypersonic Missile Test off USS *Zumwalt*," *USNI News,* February 1, 2013, https://news.usni.org/2023/02/01/navy-planning-for-december-2025-hypersonic-missile-test-off-uss-zumwalt#:~:text=%E2%80%9CIt's%20strategic%2C%20but%20it's%20not,told%20USNI%20News%20in%20November. Accessed on January 15, 2024.
30. Zach Abdi, "US Navy Taps Lockheed Martin For More Conventional Prompt Strike Work," *Naval News,* August 28, 2023, https://www.navalnews.com/naval-news/2023/08/us-navy-taps-lockheed-martin-for-conventional-prompt-strike/. Accessed on January 12, 2024.
31. "USS *Zumwalt* Arrives In Mississippi For Hypersonic Weapon Upgrade," *Naval News,* August 22, 2023, https://www.navalnews.com/naval-news/2023/08/uss-zumwalt-arrives-in-mississippi-for-hypersonic-weapon-upgrade/. Accessed on January 14, 2024.

Fig 2: *Zumwalt* Class Destroyer with CPS Hypersonic Missiles

Source: https://www.navalnews.com/naval-news/2023/08/us-navy-taps-lockheed-martin-for-conventional-prompt-strike/. Accessed on January 13, 2024.

The US Navy plans to deploy the IR-CPS on the DDG-1000 by 2025. While the launching platform is undergoing modifications, the weapon faces some testing hurdles. The LRHW and IR-CPS both originate from the CPS programme, jointly executed by the US Army and Navy. As per the Director, Operational Test and Evaluations (DOT&E) Annual Report, the US Navy is responsible for developing the Master Test Strategy (MTS) for Phase 1 of the CPS programme.[32] The Phase 1 test strategy includes five Joint Flight Campaigns (JFC) with the army. The first test, JFC-1, was conducted in June 2022, however, it failed because of some in-flight anomaly. The JFC-2 and JFC-3 were supposed to be conducted in 2023, but that did not happen. The delay in JFC-2 and 3, has only pushed the eventual JFC-4 and 5 flights scheduled for the fourth quarter of 2024.

32. FY 2022 Annual Report, "Director, Operational Test & Evaluation," January 2023, p. 164, https://www.dote.osd.mil/Portals/97/pub/reports/FY2022/other/2022annual_report.pdf?ver=71JCDFcAlC9z_UnuI9BOUQ%3d%3d. Accessed on January 14, 2023.

The US Air Force's AGM-183A Air-Launched Rapid Response Weapon (ARRW) Programme

Fig 3: B-52 Stratofortress Crews Participated in Hypersonic Weapon Familiarisation Training at Andersen Air Force Base, Guam, February 27, 2024

Source: https://defensescoop.com/2024/03/11/arrw-funding-fiscal-year-2025-air-force/. Accessed on March 28, 2024.

Specification: The ARRW is a conventional, air-launched, boost-glide, hypersonic weapon. It has a solid-rocket motor booster and glider protective shroud. The ARRW mounts a glider vehicle with a kinetic-energy projectile warhead.

Rationale: The ARRW is being developed to provide the US Air Force capabilities to engage with high-value, time-sensitive, land-based targets.

Funding: The US Air Force requested $162 million in FY2023 for the research and development of the ARRW. However, due to multiple test failures which ARRW faced since the prototype testing started, it was reported that the air force "…zeroed out the procurement of the Lockheed Martin AGM-183 Air-launched Rapid Response Weapon

(ARRW) hypersonic boost-glide weapon"[33] in its FY 2025 presidential budget request.

The ARRW is a conventional, air-launched, boost-glide, hypersonic weapon. It has a solid-rocket motor booster and glider protective shroud. The ARRW mounts a glider vehicle with a kinetic-energy projectile warhead.

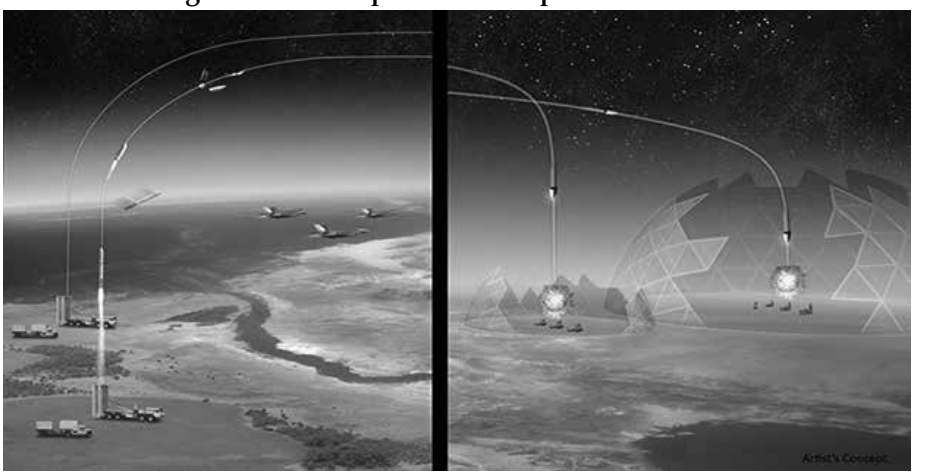
Status: The ARRW programme faced struggles right from the beginning in giving positive results during the testing phase. It was launched in 2018 with the aim of fielding the first weapon by 2022. However, in March 2023, US Air Force officials stated, "Hardware and software problems have delayed planned ARRW operational demonstration flights, precluding an initial assessment of risks to demonstrating the ARRW's intended operational effectiveness requirements."[34] Then, in August and October 2023, the US Air Force stated that it had carried out the final test flights of the AGM-183A ARRW.[35] However, in March 2024, the US Air Force again went ahead with the test of the ARRW but did not specify the outcome. It was speculated, and then confirmed, that this was the final test of the ARRW, and Lockheed Martin, which is the prime agency developing this particular weapon system, stated, "Following the recent end-to-end flight test, Lockheed Martin has completed the test program with full confidence in ARRW's revolutionary capabilities, and we stand ready to deliver this fully-qualified, hypersonic solution to the US Air Force."[36]

33. Zach Rosenberg, "Pentagon Budget 2025: USAF Funds HACM but not ARRW Development," *Janes,* March 13, 2024, https://www.janes.com/defence-news/news-detail/pentagon-budget-2025-usaf-funds-hacm-but-not-arrw-development#:~:text=The%20FY%202025%20funding%20request,and%20USD150%20million%20for%20ARRW.. Accessed on March 28, 2024.
34. FY 2022 Annual Report, Director, Operational Test & Evaluation, January 2023, p. 245, https://www.dote.osd.mil/Portals/97/pub/reports/FY2022/other/2022annual_report.pdf?ver=71JCDFcAlC9z_UnuI9BOUQ%3d%3d#page=260. Accessed on March 28, 2024.
35. John A. Tirpak, "Air Force Says ARRW Test Provides 'New Insights,' But Offers Few Specifics" *Air & Space Forces Magazine,* October 17, 2023, https://www.airandspaceforces.com/air-force-arrw-test-new-insights-few-specifics/. Accessed on March 28, 2024.
36. Stephen Losey, "US Air Force Conducts Final Test of Lockheed's Hypersonic Missile" *Defense News,* March 20, 2024, https://www.defensenews.com/air/2024/03/19/us-air-force-conducts-final-test-of-lockheeds-hypersonic-missile/. Accessed on March 28, 2024.

NEW HYPERSONIC PROGRAMMES

OpFires Launchers

Fig 4: Artistic Impression of OpFires Launchers



Source: https://www.darpa.mil/program/operational-fires.

On July 13, 2022, the DARPA successfully performed its Operational Fires (OpFires) programme test. As per the information shared by DARPA after the test, "The OpFires system achieved all test objectives, including the first ever use of a US Marine Corps (USMC) logistics truck as a medium-range missile launcher, missile canister egress, stable flight capture, and use of the US Army inventory artillery fire control systems to initiate the test mission. Lockheed Martin built the system, which includes a Northrop Grumman rocket motor, and conducted the test."[37] The prime motive behind DARPA's OpFires is to develop an advanced booster capable of employing payloads. The test, conducted in 2022, demonstrated a launch platform for short-range hypersonic boost-glide missiles.[38]

37. "Operational Fires Program Successfully Completes First Flight Test," *DARPA,* July 13, 2022, https://www.darpa.mil/news-events/2022-07-13a. Accessed on January 15, 2024.
38. Ashley Roque, "DARPA Conducts 'Successful' Live-Fire Test with OpFires Hypersonic Weapon," *Janes,* July 18, 2022, https://www.janes.com/defence-news/news-detail/darpa-conducts-successful-live-fire-test-with-opfires-hypersonic-weapon. Accessed on January 15, 2024.

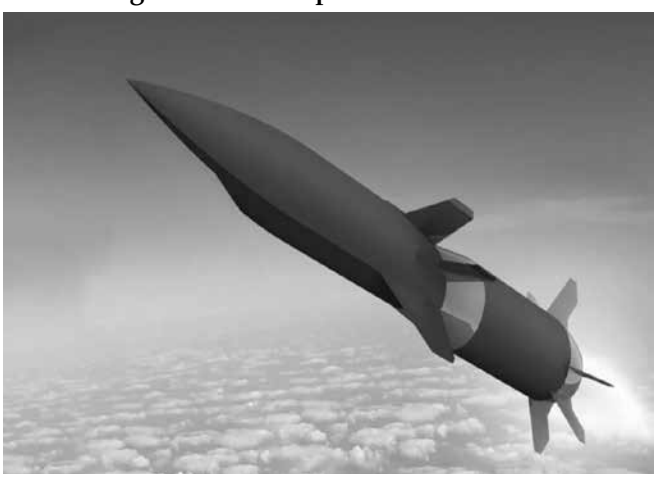
In terms of its funding, OpFires has been funded by DARPA since 2018 and had received $169 million till 2022. The US Army which will eventually use this system, spent a total of $55 million on the programme in 2021 and 2022. It requested $11 million for 2023.

The primary mission for which OpFires is being developed is to provide a ground-launched two-stage propulsive system capable of employing hypersonic payloads from ubiquitous US military trucks that can penetrate modern air defences and engage precisely with time-critical missions. According to the budget documents, the OpFires launch system will be fielded along with the LRHW.[39]

Hypersonic Cruise Missiles

Three kinds of hypersonic cruise missiles are currently under development in the US. One is funded by the DoD and based on scramjet technology. DARPA has been funding research on scramjets under the Hypersonic Air-Breathing Weapon Concept (HAWC) programme since 2014.

Fig 5: Artistic Impression of HAWC



Source: Hypersonic Air-Breathing Weapon Concept (HAWC), USA (airforce-technology.com). Accessed on January 15, 2024.

39. "U.S. Hypersonic Weapons and Alternatives", Congressional Budget Office, January 31, 2023, p. 15.

The HAWC is a joint effort of DARPA and the US Air Force to gain air-launched hypersonic cruise missiles. There are three critical technology challenges which HAWC seeks to overcome while developing a hypersonic cruise missile:

- Air vehicle feasibility.
- Effectiveness.
- Affordability.[40]

Three defence giants, Raytheon Missiles and Defence, Northrop Grumman and Lockheed Martin have teamed up for the development of the HAWC. In 2019, Raytheon and Northrop Grumman signed a contract to jointly work on the development of air-breathing hypersonic weapons. Both companies were given a contract worth $200 million for the HAWC programme. Raytheon was involved in the making of the missiles and the scramjet engines responsibility was given to Northrop Grumman. Lockheed Martin received $928 million from the US Air Force for the HAWC.[41]

In 2021, the DARPA released a press note about the successful free flight test of the HAWC. The press note stated, "The HAWC free flight test was a successful demonstration of the capabilities that will make hypersonic cruise missiles a highly effective tool for our warfighters."[42] In April 2022, the Lockheed Martin version of the HAWC demonstrated a successful free flight test. It was reported that during this test flight, the missile attained hypersonic flight. In July 2022, Raytheon's HAWC design also completed a free flight and met the test objectives successfully.[43] In January 2023, Lockheed Martin's HAWC completed its final test flight and it was deemed successful

40. Salvatore Buccellato. "Hypersonic Air-Breathing Weapon Concept (HAWC)," Defense Advanced Research Projects Agency, https://www.darpa.mil/program/hypersonic-air-breathing-weapon-concept. Accessed on January 16, 2024.
41. "Hypersonic Air-Breathing Weapon Concept (HAWC), USA," *Airforce Technology*, February 15, 2023, https://www.airforce-technology.com/projects/hypersonic-air-breathing-weapon-concept-hawc-usa/. Accessed on January 16, 2024.
42. "DARPA'S Hypersonic Air-Breathing Weapon Concept (HAWC) Achieves Successful Flight," Defense Advanced Research Projects Agency, September 27, 2021, https://www.darpa.mil/news-events/2021-09-27. Accessed on January 16, 2024.
43. n.41.

by DARPA.[44] The HAWC is a significant programme because it has resulted in two hypersonic air-breathing missile designs, one each from Raytheon and Lockheed Martin.

Hypersonic Attack Cruise Missile

Raytheon Missiles and Defence is the primary defence agency which was awarded a contract of $985 million in 2022[45] by the US Air Force. The HACM, if developed as per the plan, would be the first scramjet-powered, air-launched hypersonic missile. The Hypersonic Attack Cruise Missile (HACM) is important from another point of reference as well. It is the only project that involves another country. In 2020, the Royal Australian Air Force got involved in the HACM project through the Southern Cross Integrated Flight Research Experiment (SCIFiRE).[46] The US Air Force is the primary defence force which is currently looking forward to inducting the HACM. The air force requested $316.8 million in its FY 2023 budget submission.[47] Currently, the air force is more committed towards the HACM than any other hypersonic weapon. The reason for this commitment is because of the shelving of the AGM-183 Air-launched Rapid Response Weapon (ARRW), a hypersonic weapon. Secretary of the Air Force Frank Kendall, in 2023, told a Congressional panel "We're more committed to HACM at this point than we are to ARRW."[48]

The air force is also more interested in the development of the HACM because of the versatility of the weapon. Unlike the ARRW, which can only be mounted on bombers, the HACM has the advantage of being mounted

44. "Final Flight of HAWC Programme Screams Through the Sky," Defence Advanced Research Projects Agency, January 30, 2023, https://www.darpa.mil/news-events/2023-01-30. Accessed on January 16, 2024.
45. US Department of Defence, *Contracts,* September 22, 2022, https://www.defense.gov/News/Contracts/Contract/Article/3168041/. Accessed on January 16, 2024.
46. Air Force, "SCIFiRE Hypersonics," https://www.airforce.gov.au/our-work/projects-and-programs/scifire-hypersonics. Accessed on January 16, 2024.
47. Valerie Insinna, "Air Force Selects Raytheon in $985M Hypersonic Cruise Missile Contract," *Breaking Defense,* September 22, 2022, https://breakingdefense.com/2022/09/air-force-selects-raytheon-in-985m-hypersonic-cruise-missile-contract/. Accessed on January 17, 2024.
48. John A. Tirpak, "Kendall: Air Force 'More Committed' to HACM After Latest Unsuccessful ARRW Test," *Air & Space Forces Magazine,* March 28, 2023, https://www.airandspaceforces.com/kendall-air-force-hacm-unsuccessful-arrw-test/. Accessed on January 17, 2024.

Unlike the ARRW, which can only be mounted on bombers, the HACM has the advantage of being mounted on fighter aircraft. The HACM is being developed to provide greater defensive capabilities while securing forward-deployed assets and bases.

on fighter aircraft. The HACM is being developed to provide greater defensive capabilities while securing forward-deployed assets and bases. Nathan Greiner, a programme manager in DARPA's Tactical Technology Office, stated, while analysing defensive hypersonics, "The challenge is with regional defense when we have forward deployed assets and bases where mutually assured destruction does not apply. Hypersonics as an offensive capability from [our] adversaries tends to stress those forward deployed defenses."[49] A prototype of HACM has undergone two tests, in 2021 and 2022. It has been reported that the prototype flew more than 500 km during the tests, but it is unclear how long the scramjet was operating during the flight.[50]

Hypersonic Air-Launched Offensive Anti-Surface Warfare

Apart from the US Air Force and Army, the US Navy also looks forward to inducting hypersonic capabilities for strategic gains. Currently, the navy is exploring ways to develop and deploy the Offensive Anti-Surface Warfare (OASuW) Increment 2, more commonly known as Hypersonic Air-Launched Offensive Anti-Surface Warfare (HALO) weapon system. The HALO system will supplement the already inducted air-launched AGM-158 Long Range Anti-Ship Missile (LRASM) under the OASuW Increment 1. Raytheon and Lockheed Martin were awarded $116 million in contracts in March 2023

49. Barry Rosenberg, "DARPA is Playing Both Sides of the Ball with Both Offensive and Defensive Hypersonics," *Breaking Defense,* November 18, 2022, https://breakingdefense.com/2022/11/darpa-is-playing-both-sides-of-the-ball-with-both-offensive-and-defensive-hypersonics/. Accessed on January 17, 2024.
50. Joseph Trevithick, "Our First Glimpse of The Air Force's Hypersonic Cruise Missile," *The War Zone,* September 29, 2023, https://www.thedrive.com/the-war-zone/our-first-glimpse-of-the-air-forces-hypersonic-cruise-missile. Accessed on January 17, 2024.

for the HALO programme.[51] HALO will be a carrier-based hypersonic long-ranged air-launched weapon that will help the US Navy to have greater anti-surface warfare capabilities. Richard Gensley, a programme manager of the Precision Strike Weapons (PMA-201), stated, "As threat capability continues to advance, additional range, warfare capability and capacity are required to address the more demanding threat environment."[52] As of January 2024, Raytheon has completed the technical review of the HALO prototype. The plan is to field HALO by FY2029.

Currently, the navy is exploring ways to develop and deploy the Offensive Anti-Surface Warfare (OASuW) Increment 2, more commonly known as Hypersonic Air-Launched Offensive Anti-Surface Warfare (HALO) weapon system.

CHALLENGES IN THE US HYPERSONIC PROGRAMMES

There are multiple hurdles which the US must overcome to deploy hypersonic weapon systems in the near future. The US hypersonic programme is already facing multiple delays and at least one cancellation of the programme. As argued earlier, achieving hypersonic capabilities is not easy and requires overcoming multiple scientific hurdles. However, in the case of the US, engineering challenges are not formidable obstacles. The following are the major reasons behind the hurdles in the hypersonic programme of the US:

- **Budget Issues**: In order to counter China's and Russia's efforts, the US has spent more than $8 billion on developing hypersonic systems since 2019.[53] The DoD requested $225.5 million for its hypersonic

51. "US Navy Moves Forward With HALO Hypersonic Carrier-Based Weapon," *Naval News,* March 29, 2023, https://www.navalnews.com/event-news/sea-air-space-2023/2023/03/us-navy-moves-forward-with-halo-hypersonic-carrier-based-weapon/. Accessed on January 18, 2024.
52. Rojoef Manuel, "Raytheon Completes Technical Review of US Navy's HALO Hypersonic Missile Prototype," *The Defense Post,* January 10, 2024, https://www.thedefensepost.com/2024/01/10/us-halo-hypersonic-missile-prototype/#:~:text=%E2%80%9CAs%20threat%20capability%20continues%20to,at%20the%20contract%20award%20ceremony.. Accessed on January 18, 2024.
53. Mark Montgomery and Bradley Bowman, "The US is Failing to Quickly Hypersonic Missile Defense," *Defense News,* January 20, 2024, https://www.defensenews.com/opinion/2024/01/19/the-us-is-failing-to-quickly-field-hypersonic-missile-defense/. Accessed on January 24, 2024.

defence programme and $4.7 billion for the hypersonic weapons programme in FY2023.[54] In FY2022, the DoD requested $247.9 million for a hypersonic defence programme and $3.8 billion for a hypersonic weapons programme.[55] Though there is no open disagreement over the fund appropriation for hypersonic programmes, concerns have been raised about the appropriations. In the FY2020 appropriations request, the Defence Subcommittees of the Appropriations Committees expressed concerns directly related to funding. In a joint explanatory statement, the subcommittees noted "that the rapid growth in hypersonic research has the potential to result in stove-piped, proprietary systems that duplicate capabilities and increase costs."[56]

- **Test Failures**: One of the most important hurdles the US hypersonic programme faces is the increasing number of hypersonic test failures over the years. The US Air Force recently conducted the final test flights of its hypersonic missile programme, the AGM-183A Air-launched Rapid Response Weapon (ARRW). The ARRW programme was launched in April 2018 and originally planned to achieve initial operational deployment in 2022. However, in 2023, after conducting two test flights in August and October, the ARRW hypersonic programme was officially cancelled.[57] The Senate Armed Services Committee budget document 2023 clearly stated, "In the light of testing failures and statements from air force leadership in support of the competitor program, the committee is concerned that continued testing at the scale originally planned in the budget request seems unlikely to deliver persuasive results."[58] The

54. "Hypersonic Weapons: Background and Issues for Congress" Congressional Research Service, February 13, 2023, p. 23, https://s3.documentcloud.org/documents/23688406/r45811.pdf. Accessed on January 25, 2024.
55. Ibid.
56. Ibid., pp. 23-24.
57. John A. Tirpak, "Air Force Says ARRW Test Provides Insights,' But Offers Few Specifics," *Air & Space Forces Magazine*, October 17, 2023, Air Force Says ARRW Test Provides 'New Insights,' But Offers Few Specifics (airandspaceforces.com). Accessed on January 27, 2024.
58. Shannon Bugos, "Test Failures Put Hypersonic Program in Doubt," *Arms Control Today*, November 2023, Test Failures Put Hypersonic Program in Doubt | Arms Control Association. Accessed on January 27, 2024.

cancellation of the ARRW programme speaks volume about the hurdles in the US hypersonic ambitions.

- **Allies Commitments**: One of the reasons why the US is pursuing the hypersonic programme is to counter Russia's and China's A2/AD capabilities. However, the locations where the US can deploy such weapon systems are currently limited, especially in the Pacific theatre. More importantly, in the current scenarios, though joint collaborations between the US and Australia, and the US and Japan, are ongoing on a hypersonic programme,[59] none of the US allies in the Pacific has explicitly committed to allowing the US to base its planned hypersonic missiles near China. The US must overcome this hurdle once it deploys its hypersonic weapons.
- **Inadequate Infrastructure Capabilities:** Wind tunnel infrastructure is the most critical element when testing weapons capabilities, especially in the context of hypersonic weapons. Beyond thermal management testing, hypersonic weapons also need to be tested on the lines of aerodynamic pressures, and this is where wind tunnel infrastructure becomes critical. Currently, the United States has around 26 wind tunnels assisting in hypersonic testing, but these are decades-old installations. The Government Accountability Office report, published in 2021, indicated that "of the 26 DoD, DoE, NASA, and private U.S. wind tunnel facilities capable of supporting hypersonic research, 14 were constructed before 1970."[60]

Additional Challenges

Apart from the hurdles that the US needs to overcome to deploy its hypersonic systems, both offensive and defensive in nature, there are other issues that the US will need to look at once hypersonic weapons are deployed.

59. Shannon Bugos, "First U.S. Hypersonic Deployment on Track for 2023", Arms Control Association, November 2022, https://www.armscontrol.org/act/2022-11/news/first-us-hypersonic-deployment-track-2023. Accessed on January 27, 2024.
60. United States Government Accountability Office, "Hypersonic Weapons" March 2021, p. 27, GAO-21-378, HYPERSONIC WEAPONS: DOD Should Clarify Roles and Responsibilities to Ensure Coordination across Development Efforts. Accessed on January 27, 2024.

The issue of balancing existing strike weapons with hypersonic weapons is one such issue. It is not known how much edge a hypersonic weapon can provide against shorter-range missile defences. The current efforts in developing hypersonic and Manoeuvrable Reentry Vehicles (MaRVs) need further justification as both weapons programmes have similar capabilities in striking moving targets. This issue further raises the question of the costs associated with both programmes. According to the Congressional Budget Office (CBO) estimates, procuring 300 intermediate-range hypersonic boost-glide missiles and sustaining the missile system for 20 years would cost a total of US $17.9 billion in 2023 terms. In comparison, 300 MaRV-equipped ballistic missiles would cost a total of US $13.4 billion.[61] Besides balancing the existing strike weapons programme with the hypersonic programmes and the cost involved, the US will also have to overcome the inherent perception problem associated with hypersonic weapons. The US has been relatively clear about the roles associated with the weapons. The payload ambiguity is not something which the US essentially follows in order to maintain deterrence. However, the Conventional Trident Modification (CTM) programme, which was launched by the US Navy in 2007, was one such programme in which the navy's Trident long-range, submarine-launched ballistic missiles that were previously armed with nuclear warheads, were mated with conventional warheads. The CTM programme was eventually shelved because the US lawmakers understood the problem of warhead ambiguity and the problem of crisis instability. The US will have to factor in the problem of warhead ambiguity once hypersonic weapons are deployed for missions.

CONCLUSION

The US hypersonic programme is one of the oldest and most comprehensive in the world, and yet it has not been a success so far. While countries like Russia and China have already deployed their hypersonic systems, the US still struggles to move ahead. As argued in the article, the US hypersonic

61. n.54.

programme has its roots in the Cold War period. During this period, the hypersonic programme helped NASA develop pilot spacecraft missions. Further, the SWERVE project helped the US understand aerothermodynamics issues during the same period. This was the so-called first phase of the US hypersonic programme. During the second phase, which started in 2003, DARPA's FALCON project paved the way for the CAV. The FALCON project was envisioned while keeping the prompt global strike mission requirement in view. As argued in this article, the FALCON study was one of the US' most detailed expressions of interest in hypersonic technology. The second phase of the hypersonic programme provided critical insights about the future US hypersonic programme and became instrumental in paving the way for the CPGS. The HTV-2 and CTM were the direct outcomes of the CPGS. The current phase of the US hypersonic programme originates in the second phase. As argued in the article, the C-HGB and ARRW programmes were a continuation of the second phase programme but with advanced technologies and clarity of thought about the strategic purposes of the programme. Despite being the most comprehensive and old in years, the US hypersonic programme has not yet witnessed any deployment of such a weapon system. This paper has attempted to explain why the US hypersonic programme is still lagging and the issues that it will need to overcome once it finds its mission capabilities. There are multiple issues that the US hypersonic programme has faced over the years. Prominent among these are cost issues, test failures, and inadequate infrastructure capabilities. The secondary issues regarding hurdles relate to allies' commitments and the rationale about the weapon system compared to already existing MaRV capabilities. While these issues are being worked on at different levels, the US hypersonic programme also needs doctrinal guidance. Whether the hypersonic programme will serve only conventional missions or will also be considered for strategic purposes is still not as clear as it should be.