US HYPERSONIC DEVELOPMENTS: BREAKING BARRIERS

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INTRODUCTION

Hypersonic has become a buzzword in parts of the world where active war and conflict are ongoing and the prospects of conflict remain high. The Russia-Ukraine War has seen multiple uses of hypersonic weapons of different kinds. Russia has deployed the Kinzhal, Zircon, and Oreshnik. The Yemeni armed forces, the Houthis in particular, now claim to possess hypersonic missiles.[1] North Korea has also recently claimed to have tested hypersonic-tipped missiles.[2] China, on the other hand, seems to be leading the race in deploying hypersonic weapons.[3] India is also becoming

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1. "Yemen's Possession of Hypersonic Missiles will Change the Region's Deterrence Rules," *Yemen News Agency*, October 26, 2024, https://www.saba.ye/ar/news3388480.htm. Accessed on April 13, 2025.
2. Kelly Ng, "North Korea Says New Hypersonic Missile Will 'Contain' Rivals," *BBC*, January 7, 2025, https://www.bbc.com/news/articles/crrwyv75g5xo. Accessed on April 13, 2025.
3. David Rovella, "China Leads the World in Hypersonic Technology," *Bloomberg*, March 13, 2024, https://www.bloomberg.com/news/newsletters/2024-03-12/bloomberg-evening-briefing-china-leads-the-world-in-hypersonic-technology. Accessed on March 13, 2025.

a part of the hypersonic race and has recently tested a long-range hypersonic missile.[4] The US, on the other hand, despite being the first to develop hypersonic technology during the Cold War, has found it challenging to develop and deploy offensive hypersonic weapons. However, recently, two developments have provided a sneak peek into the US' hypersonic efforts. One development has dealt with the cancellation of the Hypersonic Air-Launched Offensive (HALO) anti-surface warfare programme, and the second pertains to the first launch of the Conventional Prompt Strike (CPS) capability utilising the US Navy's cold gas launch approach that will be used in the navy's sea-based platform fielding. This article examines both these developments and the impact of such dynamics on the trajectory of hypersonic development in the US.

The efforts and eventual acquisition of hypersonic capabilities have been an area of interest for the US, with each defence arm, the army, air force, and navy, working to develop and deploy such capabilities. However, due to many factors, the ambition for, and the eventual employment of, hypersonic capabilities still seems a distant dream for the US. This study is also essential for India, as it seeks to enhance its hypersonic capacities. Given the national security concerns, India should take a look at this hypersonic setback and its reasons while charting a clear pathway for hypersonic ambitions in terms of development and strategy.

UNDERSTANDING THE HALO

The US has again faced a significant setback in developing an offensive hypersonic system. On April 4, 2025, it was reported that the US Navy has shelved its much-solicited HALO Engineering and Manufacturing Development (EMD) programme.[5] The programme was cancelled in the fall of 2024, but information of this came

4. V. Kamalakara Rao, "DRDO 'Successfully Conducts' Flight Trial of India's First Long-Range Hypersonic Missile," *The Hindu,* November 17, 2024, https://www.thehindu.com/news/national/andhra-pradesh/drdo-successfully-conducts-flight-trial-of-indias-first-long-range-hypersonic-missile/article68878783.ece. Accessed on April 13, 2025.
5. Carter Johnston, "U.S. Navy Cancels Critical HALO Hypersonic Missile Citing Cost Concerns," *Naval News,* April 10, 2025, https://www.navalnews.com/event-news/sea-air-space-2025/2025/04/u-s-navy-cancels-critical-halo-hypersonic-missile-citing-cost-concerns/#:~:text=%E2%80%9CThe%20Navy%20cancelled%20the%-

to light recently. While giving the reasons for the cancellation, the US Navy spokesperson primarily referred to the "budgetary constraints"[6] preventing the timely completion of the programme. The cancellation, however, is not the first of its kind. In early 2024, the US had cancelled its much-touted hypersonic AGM-183A Air-launched Rapid Response Weapon (ARRW).

The HALO, also known as Offensive Anti-Surface Warfare (OASuW) Increment 2, is essentially an advanced version of the OASuW 1, a subsonic but stealthy Lockheed Martin AGM-158C Long-Range Anti-Ship Missile (LRASM). The LRASM is also an offshoot of the AGM-158 Joint Air-to-Surface Standoff Missile (JASSM). The OASuW Increment 1 was developed under the incremental approach.[7] The incremental approach, as used by the US Department of Defence, goes back to the early 1950s when the US first developed its X-15 hypersonic jet. According to the 2003 National Defence Authorisation Act (NDAA), the term incremental approach essentially "means an acquisition program that is to be conducted in discrete phases or blocks, with each phase or block consisting of the planned production and acquisition of one or more units of a major system."[8] The OASuW Increment 1 demand was first raised in response to a 2008 US Pacific Fleet Urgent Operational Need.[9]

The LRASM programme began in 2009, and, while fielding the LRASM, the US Navy stated in Financial Year (FY) 2018 that the OASuW Increment 2, aka HALO, will be required to "deliver the long-term, air-launched anti-surface warfare (ASuW) capabilities to counter 2028 threats (and beyond)."[10] On March 27, 2023, the US

20solicitation,within%20the%20planned%20delivery%20schedule.%E2%80%9D. Accessed on April 13, 2025.

6. Peter Suciu, "The U.S. Navy's Hypersonic Missile Program Is Down, but Not Out," *The National Interest*, April 24, 2025, https://nationalinterest.org/blog/buzz/the-u-s-navys-hypersonic-missile-program-is-down-but-not-out. Accessed on April 26, 2025.
7. FY18 Navy Programmes, "Offensive Anti-Surface Warfare (OASuW) Increment 1," p. 153, https://www.dote.osd.mil/Portals/97/pub/reports/FY2018/navy/2018oasuw.pdf?ver=2019-08-21-155650-680. Accessed on April 13, 2025.
8. Congress, Gov, "S. 2514 (107th): National Defense Authorization Act for Fiscal Year 2003," pp. 215-216, June 27, 2002, BILLS-107s2514pp.pdf. Accessed on April 13, 2025.
9. Office of the Under Secretary of Defence, For Acquisition, Technology, and Logistics, "Report of the Defense Science Board Task Force on the Fulfillment of Urgent Operational Needs," July 2009, https://apps.dtic.mil/sti/tr/pdf/ADA503382.pdf. Accessed on April 14, 2025.
10. n. 7.

Navy awarded two contracts to Raytheon Missiles and Defence and Lockheed Martin for the initial development of the HALO. The contracts were valued at a total of US$ 116 million.[11] The US Navy received approximately US$ 151.9 million for this programme in the FY2023 budget. According to the budget documents, the Service aimed for an initial flight test in FY2026. The budget document mentioned that "in order to counter the evolving near-peer threat capability, OASuW Inc2/HALO is required to be fielded in FY2029."[12] The decision to induct the weapon in FY2029 was based on an extension from FY2028.

The HALO's development had been under a cloud since its conceptual beginning. Since the HALO was supposed to be a hypersonic weapon, it required a scramjet-powered missile design. In March 2021, the Office of Naval Research issued a notice about the development of an experimental scramjet-powered hypersonic anti-ship cruise missile design, essentially meant to be compatible with the F/A-18E/F Super Hornet fighter jet, aka Screaming Arrow. The programme, however, was cancelled within days without specifying any reason. The programme was revived again in August 2021, but knowledge of the current progress of the programme is not in the public domain.[13]

THE HALO'S DEVELOPMENT

As mentioned, the HALO was not a new weapon system developed from scratch. The AGM-158 JASSM was the first system of its kind, and the HALO traces its roots back to it. The AGM-158 was initially

11. "Navy Moves Forward with Hypersonic, Carrier-Based Weapon," NAVAIR, March 28, 2023, https://www.navair.navy.mil/news/Navy-moves-forward-hypersonic-carrier-based-weapon/Mon-03272023-1415#:~:text=The%20contracts%2C%20valued%20at%20a,(A2%2FAD)%20environments. Accessed on April 16, 2025.
12. Joseph Trevithick, "Navy Air-Launched Hypersonic Anti-Ship Cruise Missile Makes Big Move Forward," *TWZ*, March 29, 2023, https://www.twz.com/air/navy-axes-its-hypersonic-anti-ship-cruise-missile-plans#:~:text=The%20U.S.%20Navy%20has%20halted%20plans%20to%20acquire,its%20requirements%20with%20a%20new%20focus%20on%20affordability. Accessed on April 16, 2025.
13. Steve Trimble, "U.S. Navy Revives Screaming Arrow Hypersonic Cruise Missile," *Aviation Week Network,* August 12, 2021, https://aviationweek.com/defense/missile-defense-weapons/us-navy-revives-screaming-arrow-hypersonic-cruise-missile. Accessed on April 16, 2025.

developed in the late 1990s. The US Air Force (USAF) drove its development to achieve a weapon with low-observable, standoff capabilities, and the ability to carry out precision strike missions. Lockheed Martin was tasked with designing and developing the missile, which commenced in 1998. The missile was declared operational by the USAF in 2003.[14] The AGM-158 JASSM was the baseline variant and is no longer in use. It was later developed into what is now known as the AGM-158B JASSM-ER, with the ER indicating the extended range variant, and providing a range of 1,000 km. It is to be noted here that the AGM family of cruise missiles are subsonic. The LRASM, from which the HALO directly originates, was first brought into existence in 2009. The LRASM was developed to supplement the US Navy's primary anti-ship missile, the Harpoon. It was already 40 years old in 2009 and started losing relevance because of China's sub-surface capabilities. The Harpoon faced issues such as subsonic flight, limited range, and limited targeting and navigation skills, making it less lethal when facing China's Anti-Access/Area Denial (A2/AD) capabilities.[15] In its initial development period, the LRASM had two variants, the LRASM-A and LRASM-B. The 'A' version was supposed to be a subsonic, low-flying, stealthy missile. The 'B' version was imagined to be a high-altitude supersonic, ramjet-powered anti-ship missile. However, the 'B' version did not see much progress and was cancelled in 2012.[16] One of the reasons for the cancellation was related to "tightening [of] the defence budgets."[17] The 'A' version finally received all the attention and developed into what is now AGM-158C-1. The US Navy is developing at least two variants of the AGM-158C. The first is the 'C' version, which has already been deployed on the USAF's F-15E and EX Eagle II. For the navy, the F/A-18E/F Super Hornets are available platforms for the

14. "JASSM AGM-158," Army Recognition Group, January 17, 2025, https://armyrecognition.com/military-products/army/missiles/cruise-missiles/jassm-agm-158. Accessed on April 17, 2025.
15. Tyler Rogoway, "The Navy's Smart New Stealth Anti-Ship Missile Can Plan Its Own Attack," *Jalopnik*, December 4, 2014, https://www.jalopnik.com/the-navys-smart-new-stealth-anti-ship-missile-can-plan-1666079462/. Accessed on April 17, 2025.
16. Ibid.
17. Ibid.

'C' version.[18] The development of the AGM-158C has been done while keeping in mind the A2/AD capabilities of the adversary's navy. The 'C' version employs detection through an Imaging Infra-Red (IIR) system, which can assist in precise strikes of surface vessels. Another essential feature of the 'C' version is its passive radio frequency sensors, which provide a wide area of target acquisition and help avoid detection because of non-distributive radio frequency.[19] This anti-ship missile also has a weapon data link system, which is meant to give it in-flight updates.

The AGM-158C or LRASM is already a well-equipped missile system with a substantial cost designation. The unit cost of the 'C' version missile is around US$ 3 million. This raises the question of why the HALO was needed and what led to its cancellation, which dented US hypersonic efforts.

WHY WAS THE DEMAND FOR THE HALO RAISED?

The US Navy budget document of FY2023 mentioned that the development of this hypersonic system is related to A2/AD counter-measures.[20] The US started thinking about effectively countering the A2/AD capabilities of its adversaries right after the end of the Cold War. General Ronald Fogleman, then Air Force Chief of Staff, stated the following concern in 1996:

> Saturation ballistic missile attacks against littoral forces, ports, airfields, storage facilities, and staging areas could make it extremely costly to project US forces in a disputed theater, much less carry out operations to defeat a well-armed aggressor. Simply the threat of

18. Jospeh Trevithick, "Stealthy AGM-158C Long-Range Anti-Ship Missile To Arm F-15EX, F-15E," *TWZ,* January 8, 2025, https://www.twz.com/air/f-15exs-and-f-15es-set-to-get-stealthy-agm-158c-long-range-anti-ship-missiles. Accessed on April 18, 2025.
19. Richard Scott, "USAF Plans LRASM Anti-Ship Missile Integration on F-15E, F-15EX," *Naval News,* January 10, 2025, https://www.navalnews.com/naval-news/2025/01/usaf-plans-lrasm-anti-ship-missile-integration-on-f-15e-f-15ex/#:~:text=The%20decision%20to%20add%20the,Command%20Urgent%20Operation%20Need%20statemen. Accessed on April 18, 2025.
20. Department of Defence: Fiscal Year (FY) 2023 Budget Estimates, "Navy," April 2022, https://www.secnav.navy.mil/fmc/fmb/Documents/23pres/RDTEN_BA1-3_Book.pdf. Accessed on April 18, 2025.

> such enemy missile attacks might deter US and coalition partners from responding to aggression in the first instance.[21]

Secretary of Defence Donald Rumsfeld, on January 31, 2002, also highlighted the same concerns and argued, "We [the US] must, therefore, reduce our dependence on a predictable and vulnerable base structure, by exploiting several technologies that include longer-range aircraft, unmanned aerial vehicles, and stealthy platforms, as well as reducing the amount of logistical support needed by our ground forces."[22] The A2/AD problem for the US became a much more holistic denial strategy which could be implemented by its adversaries. Admiral Jay Johnson, who was the Chief of Naval Operations (CNO) in the late 1990s, argued:

> I anticipate that the next century will see those foes striving to target concentrations of troops and materiel ashore and attack our forces at sea and in the air. This is more than a sea-denial threat or a Navy problem. It is an area-denial threat whose defeat or negation will become the single most crucial element in projecting and sustaining US military power where it is needed.[23]

After the end of the Cold War, extended-reach operations became very important for US' strategic interests, and so were the adversaries' capabilities in this domain. For the US Navy, to successfully deter its adversaries, the post-Cold War era demanded an assured access strategy. By the end of the 20th century, the US Navy had four strategic concepts: forward presence, deterrence, sea and area control, and power projection.[24] The 2001 Quadrennial Defence Review (QDR) Report (now known as the National Defence Strategy)

21. Andrew Krepinevich, Barry Watts and Robert Work, "Meeting the Anti-Access and Area-Denial Challenge," Centre for Strategic and Budgetary Assessments, p. ii, 2003, https://csbaonline.org/uploads/documents/2003.05.20-Anti-Access-Area-Denial-A2-AD.pdf. Accessed on April 18, 2025.
22. Congress, Gov, "S.Hrg. 107-771 — Department of Defense Policies and Programs to Transform the Armed Forces to Meet the Challenges of the 21st Century," pp. 77-78, September 4, 2002, https://www.congress.gov/event/107th-congress/senate-event/LC17732/text. Accessed on April 20, 2025.
23. Krepinevich, et. al., n. 21.
24. Ibid.

first brought up the issue of "assurance of access" to the US' extended facilities and the region. This document was also the first to refer to the development of capabilities for "sustained operations at great distances with minimal theatre-based support."[25] Not only official documents but also higher officials of the US Navy started arguing about the need for precision strike capabilities in the early 2000s. In October 2002, Admiral Vern Clark, former US CNO wrote the article "Sea Power 21: Projecting Decisive Joint Capabilities." In this, Clark argued that future operations at sea would require the US Navy to enable "ForceNet, an overarching effort to integrate warriors, sensors, networks, command and control, platforms, and weapons into a fully netted, combat force." He further stated that the Intelligence, Surveillance, and Reconnaissance (ISR) capabilities would help the US Navy to create a knowledge well, which would help in a "full array of sea strike operations- next-generation missiles capable of in-flight targeting, aircraft with standoff precision weapons."[26] While for the first decade of the 21st century, the US primarily focussed on the Global War on Terrorism, future threats posed by states remained an area of concern for the US. The 2010 QDR, while heavily referring to threats posed by non-state actors, still managed to bring in the issues related to the future anti-access capabilities of some states. The 2010 QDR stated that the US must "deter and defeat aggression in anti-access environments", and to do so, the QDR mentioned expansion of "future long-range strike capabilities."[27]

The 2015 QDR was more vocal on the issue of overcoming A2/AD capabilities and enhancing long-range standoff capabilities. This particular QDR stated clearly that the US requires advanced air-to-surface missiles to perform precision strikes. This QDR also invoked

25. U.S. Department of Defence, "Quadrennial Defense Review Report," September 30, 2001, p. 4, https://history.defense.gov/Portals/70/Documents/quadrennial/QDR2001.pdf?ver=AFts7axkH2zWUHncRd8yUg%3D%3D. Accessed on April 18, 2025.
26. Admiral Vern Clark, "Sea Power 21: Projecting Decisive Joint Capabilities," U.S Naval Institute, October 2022, https://www.usni.org/magazines/proceedings/2002/october/sea-power-21-projecting-decisive-joint-capabilities#:~:text=%22Sea%20Power%2021%22%20is%20our,execution%2C%20and%20dedicated%20to%20transformation. Accessed on April 19, 2025.
27. U.S. Department of Defence, "Quadrennial Defense Review Report," February 2010, p. 32, https://history.defense.gov/Portals/70/Documents/quadrennial/QDR2010.pdf. Accessed on April 20, 2025.

the Chinese A2/AD abilities for the first time, which could prevent the US' future military operations. This QDR was also important for developing the HALO because it mentioned developing offensive strike capabilities, such as the offensive anti-surface warfare weapons. Besides the observations by the QDR, the following three points also became important for the US in developing hypersonic systems such as the HALO.[28]

China's Greater Shipbuilding Capacity

Since the end of the Cold War, the US Navy has enjoyed a greater edge in the number of its surface and subsurface vessels. However, China has endeavoured to overcome the US Navy's numbers. In a recent US Navy briefing, the Office of Naval Intelligence presented compiled data that showed "a growing gap in fleet sizes is being helped by China's shipbuilders *being more than 200 times* more capable of producing surface warships and submarines."[29]

China's Modernisation of Surface Fleets

China's naval battle fleet now comprises a range of modern and lethal offensive systems. The Type 055, which entered service in 2020, has hot- and cold-launched missile systems. This allows China to load various missile systems, such as the YJ-18, CJ-10, YJ-83, HQ-16 and HQ-9, and the Yu-8 and DK-10 missiles. Most importantly, China has also ensured equipping of its missiles with counter-measures to help avoid anti-ship missiles in the Pacific region.[30]

Integration of Hypersonic Systems for A2/AD Superiority

Besides building a substantial navy, China has equipped its surface fleets with hypersonic systems. China's YJ-21 hypersonic anti-ship

28. U.S. Department of Defence, "Quadrennial Defense Review Report," 2014, p. 30, https://www.acq.osd.mil/ncbdp/docs/2014_Quadrennial_Defense_Review.pdf. Accessed on April 20, 2025.
29. Joseph Trevithick, "Alarming Navy Intel Slide Warns of China's 200 Times Greater Shipbuilding Capacity," *TWZ,* July 11, 2023, https://www.twz.com/alarming-navy-intel-slide-warns-of-chinas-200-times-greater-shipbuilding-capacity. Accessed on April 20, 2025.
30. Joseph Trevithick, "Our Most Detailed Look Yet At China's Type 055 Super Destroyer," *TWZ*, August 3, 2025, https://www.twz.com/our-most-detailed-look-yet-at-chinas-type-055-super-destroyer. Accessed on April 20, 2025.

missile has an average speed of Mach 6 and a terminal velocity of Mach 10. Recently, China has also displayed an air-launched version of the YJ-21. Along with the DF-21D and DF-26, the YJ-21 is being developed to boost the Chinese Navy's A2/AD superiority.[31]

CONVENTIONAL PROMPT STRIKE (CPS) AND HYPERSONIC GLIDE VEHICLES (HGVs)

While the HALO has been shelved because of budgetary concerns, the US Navy is still developing other systems that will help it to integrate hypersonic technology at a higher pace. On March 2, 2025, it was reported that the US Navy Strategic Systems Programme (SSP) had successfully tested an end-to-end flight test of a conventional hypersonic missile under the umbrella of the CPS capability.[32] This test was also the first of its kind because of the utilisation of a 'cold gas launch' approach, reflecting the technology where the rocket motor of the missile ignites after the missile has left its silo.

The CPS programme is meant to develop and test hypersonic boost-glide missiles, particularly for longer-range strikes within a time-sensitive environment. In June 2022, the US Navy tested a single CPS all-up round missile prototype at Hawaii's Pacific Missile Range Facility. The test, however, encountered an "in-flight anomaly… which impeded data collection across a segment of the planned flight profile."[33] In 2023, the US Navy and Army initiated flight testing of the AUR missile prototype but again faced several failures, preventing the missile launch.[34] In 2024, the CPS programme again conducted two additional end-to-end flight tests of the AUR

31. Liu Zhen and Enoch Wong, "Are Beijing's Hypersonic Anti-Ship Missiles in Taiwan Strait a Warning for US?" *SCMP*, April 2, 2025, https://www.scmp.com/news/china/military/article/3304842/are-beijings-hypersonic-anti-ship-missiles-taiwan-strait-warning-us. Accessed on April 20, 2025.
32. U.S. Department of Defence, "U.S. Navy Proves Sea-Based Hypersonic Launch Approach," May 2, 2025, https://www.defense.gov/News/Releases/Release/Article/4172652/us-navy-proves-sea-based-hypersonic-launch-approach/. Accessed on May 10, 2025.
33. "Conventional Prompt Strike (CPS) Programme, USA," *Naval Technology*, March 15, 2024, https://www.naval-technology.com/projects/conventional-prompt-strike-cps-programme-usa/?cf-view. Accessed on May 10, 2025.
34. Ibid.

that were deemed successful.[35] The March 2, 2025 test is significant for the US hypersonic efforts as it can pave the way for the navy and army to fulfil their hypersonic requirements.

CONCLUSION

Given the developments, the US Navy has developed standoff capabilities in the Pacific region. The HALO was another answer to China's future A2/AD problems. A hypersonic missile provides speed, manoeuvrability, and low-level flying capability to avoid detection by air defences effectively. The LRASMs already have two of these capabilities: low-level flying and manoeuvrability. While the HALO was referred to as "a critical asset", it could not overcome issues related to cost and industrial planning. Its cancellation is based on the cost-return issue. When estimating the ARRW programme, which has already been shelved, the Congressional Budget Office (CBO) estimated a cost of US$15-18 million per ARRW hypersonic missile.[36] There is also the issue of industrial planning, which the HALO faced right from the beginning of the programme. In 2024, the Government Accountability Office (GAO) critically reviewed the six ongoing hypersonic programmes and stated that four of these six programmes, including the HALO, did not "solicit and incorporate direct and timely user feedback or have plans to do so in the future." The report also mentioned that these four programmes have failed to take "full advantage of modern engineering techniques" to develop the hypersonic systems.[37]

Hypersonic development has become an imperative area of interest for the US. However, despite being the first country to start a programme on hypersonic technology, the goal of having a

35. U.S. Department of Defence, "Army and Navy Successfully Test Conventional Hypersonic Missile," December 12, 2024, https://www.defense.gov/News/Releases/Release/Article/3999835/army-and-navy-successfully-test-conventional-hypersonic-missile/. Accessed on May 10, 2025.
36. John A. Tirpak, "CBO Estimates $15-18 Million Cost Per ARRW Hypersonic Missile," *Air & Space Forces Magazine*, February 1, 2023, https://www.airandspaceforces.com/cbo-estimates-15-18-million-cost-per-arrw-hypersonic-missile/#:~:text=The%20unit%20cost%20of%20a,new%20report%20from%20the%20Congressional. Accessed on April 21, 2025.
37. GAO: U.S. Government Accountability Office, "Hypersonic Weapons: DOD Could Reduce Cost and Schedule Risks by Following Leading Practices," July 29, 2024, https://www.gao.gov/products/gao-24-106792. Accessed on April 21, 2025.

proper hypersonic system still seems a dream. While the reason for cancelling the HALO was based on financial constraints, a closer look also reveals other issues. While pushing forward numerous weapons projects, the US military-industrial complex fails to cross-check the existing industrial capacity and the subsequent cost assessment. Therefore, the new, more challenging security environment requires the United States to be more cautious when starting new weapons programmes that become unsuccessful in the long run. Given that India's hypersonic ambitions are also based on long-term Research and Development (R&D), particularly through the Defence Research and Development Organisation (DRDO), the US' setbacks accentuate the extreme complexity of hypersonic development. In this scenario, in India, some lessons can be particularly drawn. India could follow an incremental and research-intensive approach without subjecting itself to the race the US is involved in.