Research at Hyper Speed

By Dr. Rachel Hochhalter
Director, Hypersonic Technology Office, Aerospace Systems Directorate, Wright Research and Development Laboratory

A Mach 5 Hypersonic Test Vehicle (HTV-2) is prepared for a test flight at the Pacific Missile Range Facility in Hawaii. The HTV-2 is a joint effort between the Defense Advanced Research Projects Agency and the Air Force Research Laboratory to develop and flight test a hypersonic glide vehicle capable of sustained flight at speeds in excess of Mach 20.

Series: Profiles: R&D Outlook 2015

Topics: Hypersonics, Propulsion

Keywords: Hypersonic, Mach, Speed, T-38A, Scramjet, Rocket, U.S. Army Capabilities Development Command, Aviation Research Laboratory

Part 1: Hypersonic Flight, Aviation Research Laboratory, Scramjet Propulsion

Part 2: Hypersonic Flight, Aviation Research Laboratory, Scramjet Propulsion, Rocket Propulsion

Part 3: **Research at Hyper Speed**

In the spring of 2008, the Department of Defense (DOD) began a plotting-counting-and-listing exercise to determine the number of hypersonic ground test facilities and flight test capabilities required to support a hypersonic weapon – while maintaining a robust science and technology program.

Beginning in December, Professor Frederick Ordway from Cambridge University in Bristol and I from the Aerospace Research and Development Laboratory (ARDL) at Wright-Patterson AFB, Ohio, led a team of 20 people from government, academia and industry to develop a roadmap for hypersonic technology development. Ordway's team included Dr. Jim Rodgers (scramjet and detonation) and Dr. Jim Moran (hypersonic aerodynamics). Our team was composed of people who had worked on the Mach 5 Hypersonic Test Vehicle (HTV-2) and Scramjet Flight Experiment (HyFly) programs.

A HTV-2 prior to the hypersonic flight test. (US Air Force)

The speed and range of hypersonic weapons and their ability to maneuver and make strike decisions in real time, coupled with the ability to operate in a contested environment, drive the need for a robust hypersonic weapon to be a priority for the Department of Defense. Hypersonic weapons are a game changer for the warfighter.

In response, the Defense Department has pushed forward coordinated research and development efforts in hypersonic technology, including the Hypersonic Test Bed (HTB) and the Hypersonic Flight Demonstrator (HFD) programs. These programs are the first steps of what, upon, or at least after, a pilot or flight experiment is scaled to target. These tools have enabled both ground-based robustness and flight-based performance to be addressed in a cost-effective manner.

Leveraging the current capabilities and technical expertise in academia, the Defense Research and Engineering Enterprise (DRE) has established a hypersonic roadmap to focus its efforts and to ensure a robust science and technology program.

The U.S. Air Force-centered Accelerated Studies continued the first hypersonic roadmap that was published, building on work by the Department's Hypersonics Science Board (HSB) and the Air Force Research Laboratory (AFRL) Hypersonics Technology Assessment (HTA) and Hypersonics Roadmap (HRM). The Fiscal Year (FY) 2009 HSB roadmap focus was on the long-term, 20 to 30 years, the AFRL HTA was a near-term, 5 to 10 years, and the AFRL HRM was a mid-term, 10 to 20 years. The Accelerated HRM is explained in the future steps.

A HTV-2 in flight. (US Air Force)

U.S. CONVOY CAPABILITIES DEVELOPMENT COMMAND'S ARMY RESEARCH LABORATORY (ARL)

ARL engaged Texas and Ga Tech to develop a roadmap for hypersonic technology. Dr. Jim Moran led the Ga Tech team, and I led the Texas team. Professor Ordway led the Cambridge University team in Bristol, United Kingdom.

Hypersonics is a piece of the three-volume Rocket and Hypersonic Propulsion Roadmap, which also includes Rocket Propulsion and Air-breathing Propulsion. The Rocket Propulsion roadmap was led by Dr. Mark Ott of the Aerospace Corporation, and the Air-breathing Propulsion roadmap was led by Professor Ordway and Dr. Jim Rodgers.

A HTV-2 in flight. (US Air Force)

The Accelerated Hypersonic Roadmap was completed in November 2009 and was presented to the Hypersonics Science Board, the Defense Science Board, the Defense Research and Engineering Enterprise, and the Air Force Research Laboratory. The roadmap was also presented to the Hypersonics Technology Conference in Chattanooga, Tennessee, in December 2009 and to the Hypersonics Technology Conference in Bristol, UK, in 2010. Terms of these activities will extend from 5 years to the hypersonic regime, and thus I also have a three-year roadmap plan that was being in subject.

The U.S. Air Force Research Laboratory's Hypersonic Technology Vehicle-2 (HTV-2) is a Mach 20 glide vehicle that will be used to study the feasibility of hypersonic flight. The HTV-2 is a joint effort between the Defense Advanced Research Projects Agency and the Air Force Research Laboratory to develop and flight test a hypersonic glide vehicle capable of sustained flight at speeds in excess of Mach 20. Twenty of these vehicles will be built and flight tested over the next five years. (Artist's rendition)

Hypersonic technology is the key to keeping long-range missiles under the Protection Strike Missile Capability (PSMC) and Prompt Global Strike (PGS) programs. The Air Force Research Laboratory (AFRL) has been working hypersonic technology for many years, and the Defense Department has been working PGS for a decade. The Department of Defense (DOD) has established a roadmap for sustained capability that supports the effort building, protecting and the enabler. The Hypersonic Technology Roadmap is a key piece of the Department's effort to provide sustained, robust, scientific and technical

The Hypersonic Test Facility (HTF) is a Mach 5 wind tunnel capable of testing full-scale hypersonic vehicles. (US Air Force Research Laboratory)

AFRL scientists are using high-fidelity computational mechanics tools that include "multi-physics" capabilities to predict the performance of hypersonic vehicles. These tools are being used to develop Mach 5 wind tunnels and flight test vehicles, and to develop and validate the dynamic stability and flight control of hypersonic vehicles. Hypersonic vehicles are being developed to provide a robust capability to deliver a wide variety of payloads to various locations within a short amount of time.

Mobile Launcher assembly and checkout of the Hypersonic Test Facility (HTF) at the Arnold Engineering Development Complex. (US Air Force Research Laboratory)

The Hypersonic Flight Demonstrator (HFD) is a joint effort between the Defense Advanced Research Projects Agency and the Air Force Research Laboratory to develop and flight test a hypersonic vehicle capable of sustained flight at speeds in excess of Mach 5. The HFD will be launched from a B-52 bomber and will be used to study the feasibility of hypersonic flight. The HFD will be used to study the feasibility of hypersonic flight. The HFD will be used to study the feasibility of hypersonic flight. The HFD