

# Hypersonics 101

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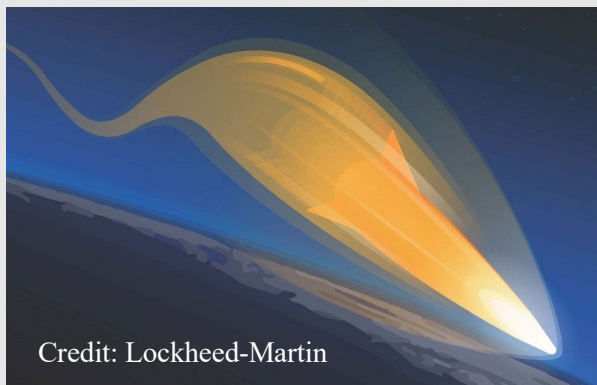
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# Hypersonics: Definition and Missions



- Hypersonic vehicles fly faster than Mach 5 (3,500 mph)
- Variety of missions and vehicle types
  - **National security:** \$4B+ in 2024 U.S. Defense Budget
    - Boost glide, scramjet-powered, defense
  - **Civil space:** NASA, emerging space economy
    - Earth (Dragon), Lunar return (Orion), Mars landers
  - **Commercial aviation:** Sometime in the future



Credit: Lockheed-Martin

Boost glide missile



Space capsule



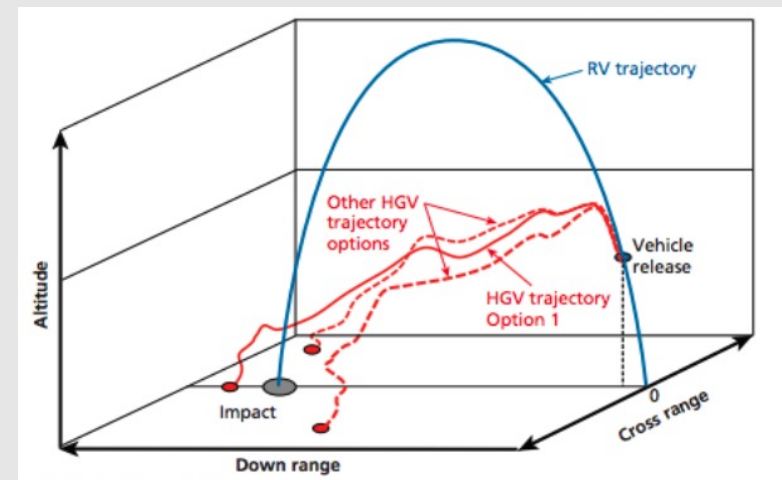
Credit: Boeing

Passenger jet

# Hypersonics in National Security



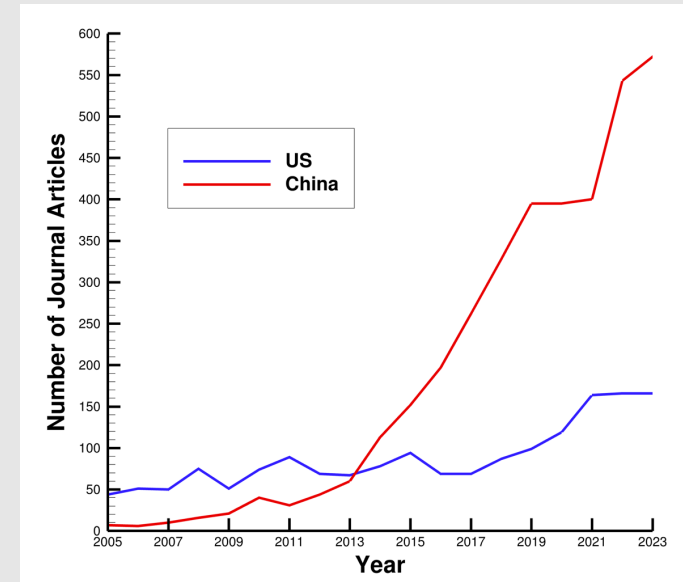
- Hypersonics is a top priority for U.S. DOD
  - *Weapons*: Boost glide, cruise missile, tactical, strategic
  - *ISR Platforms*: Upgrade from SR-71 Blackbird
  - *Defense*: Respond to other nations (China and Russia)
  - *Participants*: Army, Navy, Air Force, Missile Defense Agency
- Challenges represented by hypersonic weapons
  - *Speed*: compressed response time
  - *High altitude*: limited aero control
  - *Maneuvering*: unpredictable path
  - Complicates tracking and targeting



# National Security: China



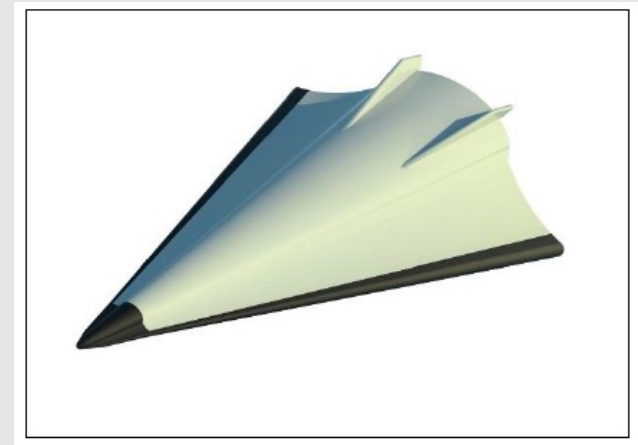
- Major national investment: One of 16 “mega” projects
  - Weapons, space, boost-glide, scramjet
  - Infrastructure, flight tests, workforce, academia
  - Surpassed the U.S. in research papers
  - “Around the world” test in August 2021
- Operational capability
  - Hypersonic Glide Vehicle
  - Fielded: October 2019



# National Security: Russia



- Advanced capabilities dating back to the Soviet era
- Kinzhal: Air-launched ballistic missile
  - Aircraft-launched, nuclear capable
  - Fielded: December 2017
  - Employed against the Ukraine
- Avangard: Hypersonic Glide Vehicle
  - Launched on ICBM
  - “Unlimited range”
  - May carry nuclear warhead
  - Fielded: December 2019





- Current missile projects
  - Long Range Hypersonic Weapon (LRHW) – Army
  - Conventional Prompt Strike (CPS) – Navy
  - Hypersonic Attack Cruise Missile (HACM) – Air Force
  - Air-launched Rapid Response Weapon (ARRW) – Air Force
- Current defensive efforts
  - Hypersonic interceptors (MDA, DARPA)
  - Space-based sensing (DARPA)



# Hypersonics In Civil Space



- Primary missions
  - Return of cargo and crew from Space Station, Moon, etc.
  - Exploration of planets and moons (Mars, Venus, Titan, etc.)
  - Space Economy: Manufacturing, processing, tourism, etc.



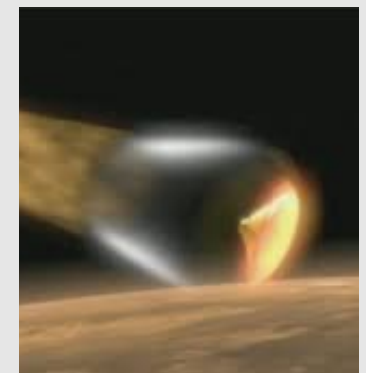
Orion:  
Lunar Return  
(NASA/  
Lockheed)



Crew Dragon:  
LEO Return  
(NASA/  
SpaceX)



Dream Chaser:  
LEO Return  
(NASA/  
Sierra-Nevada)



Mars 2020:  
Mars Landing  
(NASA/  
Lockheed)

# Hypersonics Workforce Development



- National shortage of hypersonics ready workforce
- Engineers and Researchers: Universities
  - Hypersonics is advanced: rarely mentioned in undergrad
  - Graduate level courses
    - Fluids, thermal, materials, structures, controls, propulsion
  - Graduate Certificates: Subset of a Masters Degree
    - Available to nondegree participants
- Technicians: Trade Schools, Community Colleges
  - Manufacturing, instrumentation, testing