

# Hypersonics Overview

*PRESENTED BY*

George Leuenberger, Strike and Aerospace Systems



# Hypersonics 101

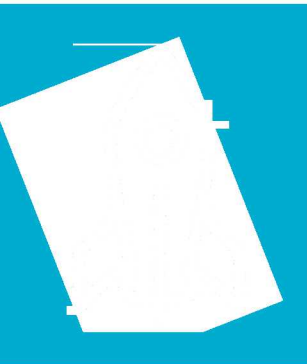


# Hypersonics 101

- Hypersonic is defined as five times the speed of sound.
- The speed of sound is about 750 mph\* or about 1000 feet per second\*.
- The speed of sound is the basis for a unit called Mach Number.
- A mile is 5280 feet, so the threshold for hypersonic flight is about a mile per second, or Mach 5
- Advanced fighters fly at about Mach 3; the SR-71 flew about Mach 4. The fastest human-piloted aircraft (X-15) achieved Mach 6.7.
- For reference, earth orbital velocity is about 25,000 feet per second and provides an upper limit to the hypersonic flight regime.

\* At flight altitude

## Engineering Challenges



Vehicle shape changes in hypersonic flight, creating challenges for flight control

Difficult to simulate velocity, temperature, and Mach number on the ground

Difficult to design sensors & actuators that can operate in a hypersonic flight environment

Calculations are extremely time consuming

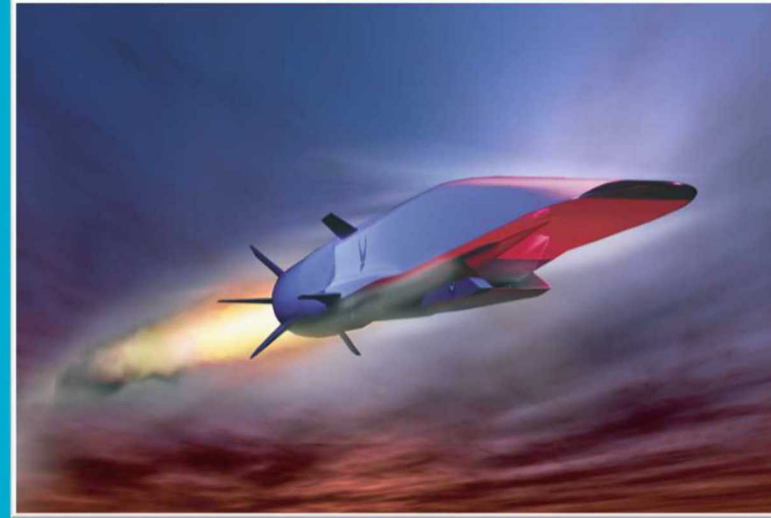


# Different Hypersonic Systems



## Boost-Glide Systems

- Rocket boosted to velocity outside the atmosphere
- Reenters and establishes glide across upper atmosphere (near space)
- Cruise is typically between M 5 - 25
- Dives to target

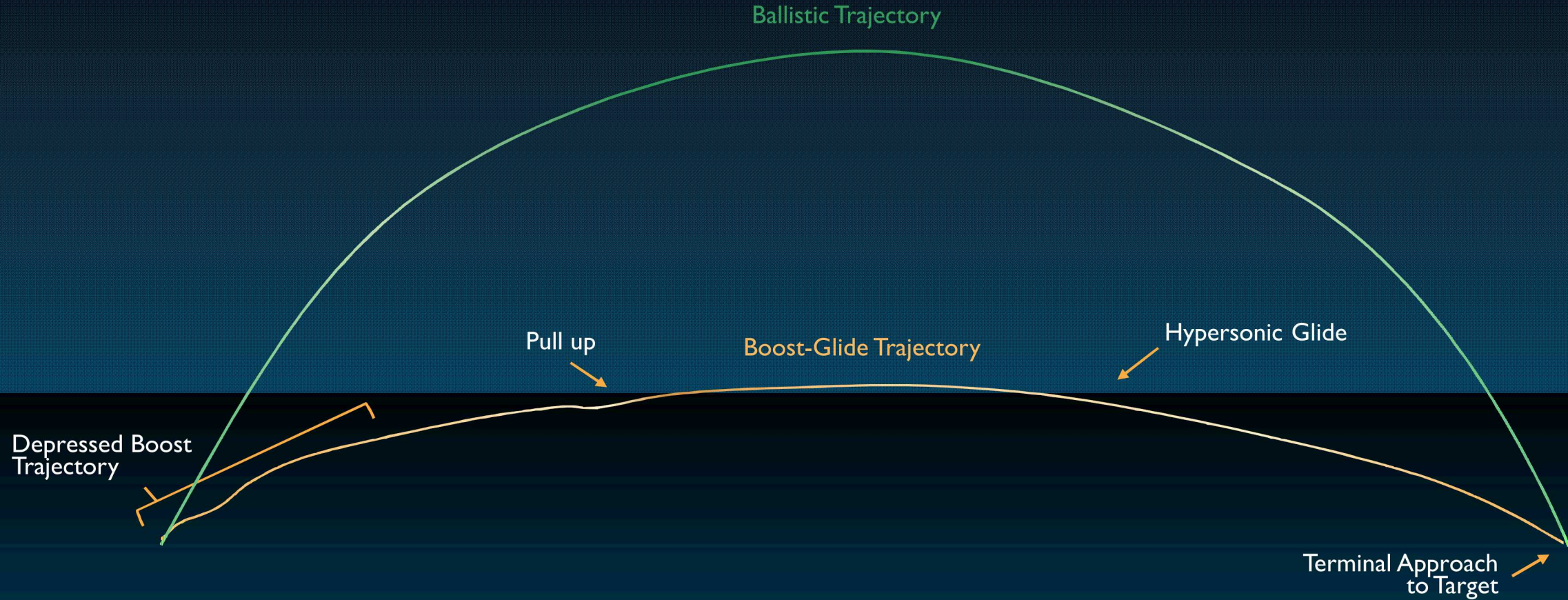


## Air-Breathing Systems

- Rocket boosted into altitude and velocity
- SCRAMJET propulsion cruise across upper atmosphere
- Cruise is typically between M 5 - 6
- Glides to target

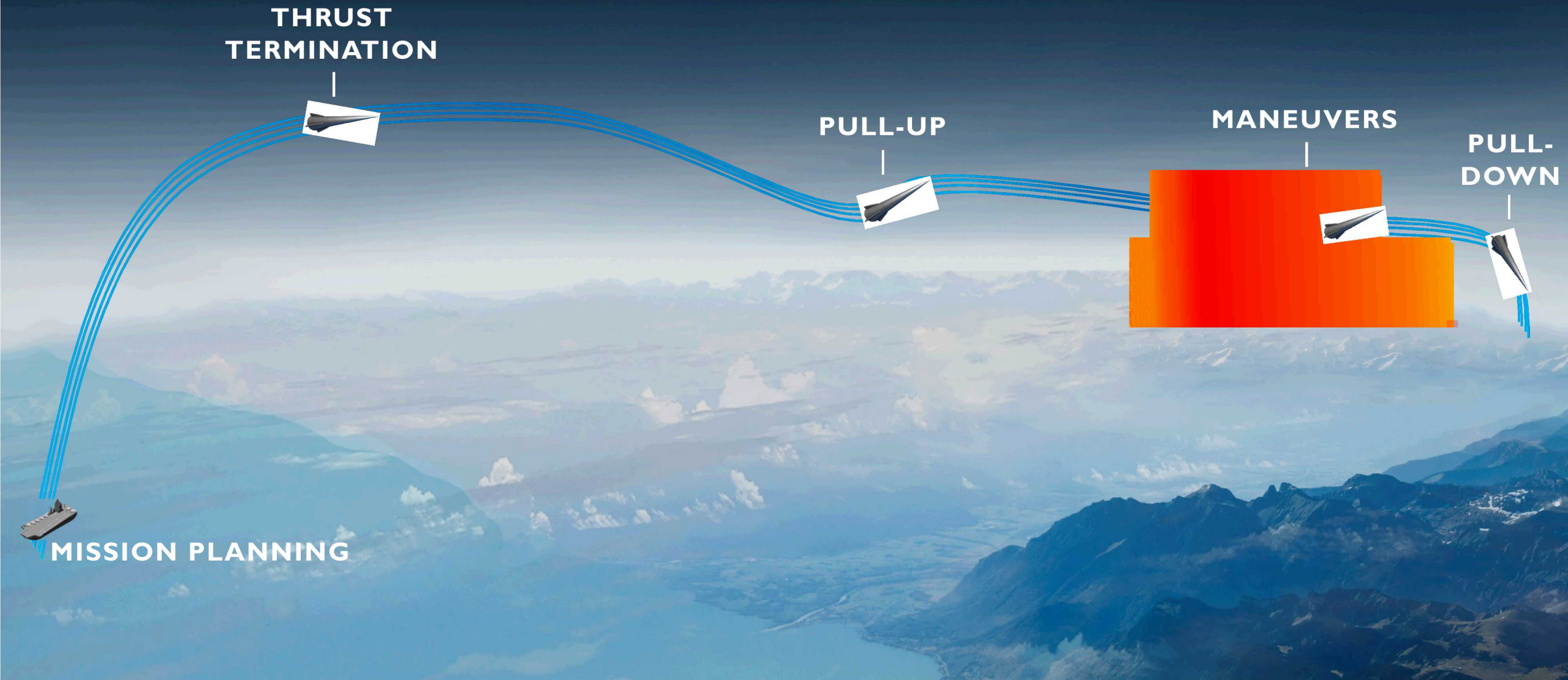
# Why Hypersonic Glide?

*Hypersonic systems fly distinctly different trajectories from Ballistic systems*





# Operational View





# Sandia's History of Boost-Glide System Development and Flight Testing





# History of Hypersonics at Sandia National Labs

## *Sandia Winged Energetic Re-entry Vehicle Experiment (SWERVE)*

- SWERVE started in the 1970s and culminated with a successful flight test in 1985.
- The vehicle was launched from Sandia's Kauai Test Facility, in Hawaii, on a Strypi IX booster.
- The test demonstrated a sophisticated maneuvering reentry vehicle technology.
- The flight was the first step in the development of a long-range smart weapon system



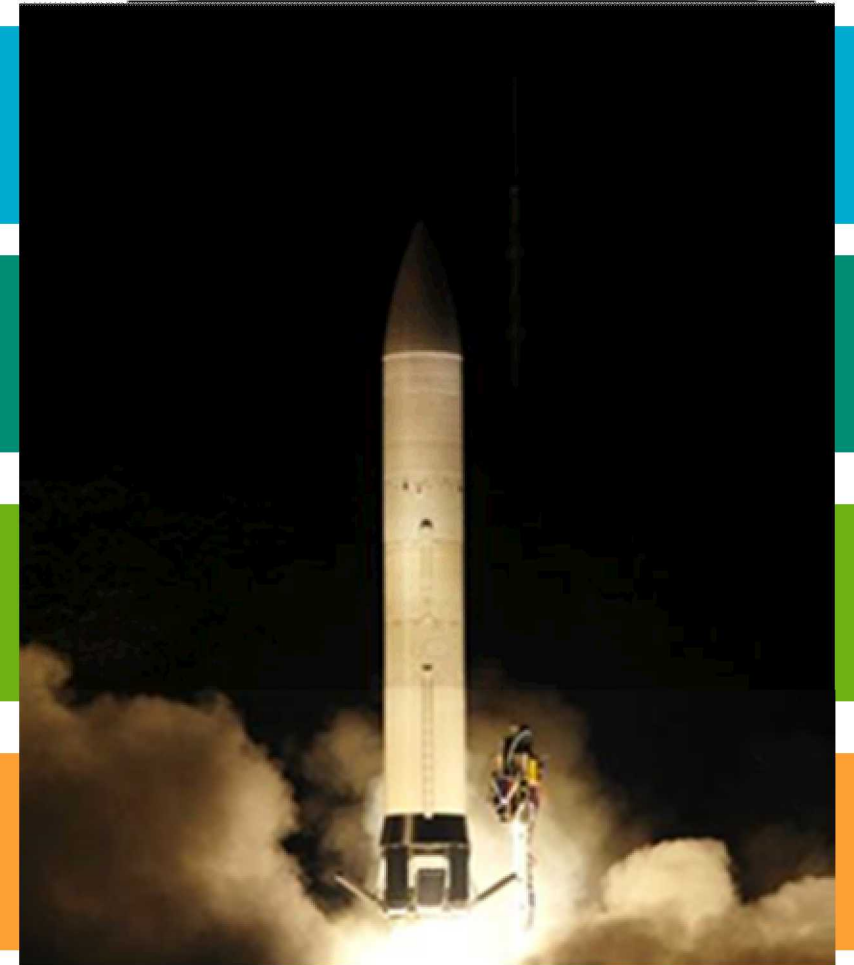
Sandia's Kauai Test Facility



# History of Hypersonics at Sandia National Labs

## *Advanced Hypersonic Weapon 1 – Flight Test 1 (AHW FT1A)*

- AHW FT-1A had a successful flight test in November 2011.
- The three-stage booster system and glide vehicle were developed by Sandia under the direction of the USASMDC/ARSTRAT.
- The test flight represented about four years of work for up to 200 Sandia employees across the Labs.
- AHW FT-1A built upon a foundation of work from as long as 35 years ago, including SWERVE, the Strategic Target System (STARS), and the Tactical Missile System-Penetrator (TACMS-P).



AHW-FT1A

# History of Hypersonics at Sandia National Labs

*Conventional Prompt Strike – Flight Experiment I Test (CPS – FEI)*

- On behalf of the Department of Defense and Navy Strategic Systems Programs, Sandia conducted the FE-1 test from its Kauai Test Facility in October 2017.
- The Sandia team served as the lead technical integrator.
- The flight test collected data on hypersonic boost-glide technologies which will anchor ground testing, modeling, and simulation of future CPS concepts.







# The Future of Hypersonics



# Autonomy for Hypersonics

Hypersonics provide a lot of military utility

- Hypersonics offer survivability and utility at long/strategic ranges, since they travel at exceptional speeds and are less susceptible to anti ballistic missile countermeasures and other defensive systems

These systems will offer the most utility if they are able to:

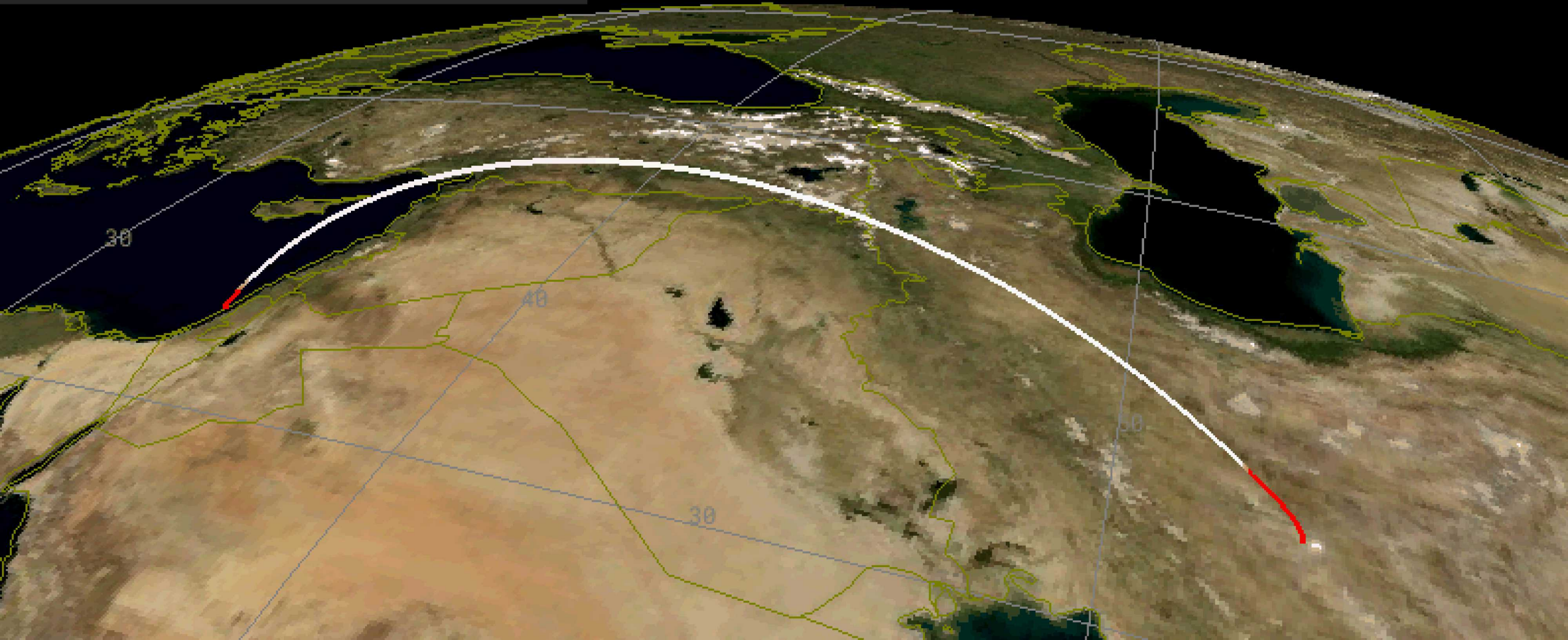
- Utilize rapidly constructed flight plans (enable speed of action)
- Navigate without GPS
- Perceive their environment and adapt to it to counter moving targets
- Employ tactics and engagement strategies that are highly effective in complex, rapidly evolving environments and heavily defended areas
- Cooperate with other hypersonic systems





# Mod/Sim Environment

To build the necessary AI, we need tools that aim to improve our ability to model key components of the complex environment.



# Evolution of Hypersonic Strike Capability

