AF Hypersonic Vision …

Airbreathing hypersonic platform technologies to produce revolutionary warfighting capabilities

Goal: S&T efforts to develop and mature robust, comprehensive technology options for:

- **High Speed Strike**
- **Penetrating Regional ISR/Strike**

AFRL'S Strategy Provides Incremental, Progressive Development of Hypersonic S&T

Public Release #88ABW-2012-2266

Overview

- **Recent Developments**
- **High Speed Weapon portfolio**
- **High Speed Aircraft portfolio**

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Recent Developments

- **Demonstration of Technology Maturity**
  - X-51A Scramjet Engine Demonstration
- **Development of Advanced Technologies**
  - HIFiRE Flight 2
- **Exploration of Applications**
  - Mission Analyses and Trade Studies

Making Hypersonics Practical & Useful

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X-51A Scramjet Engine Demonstration

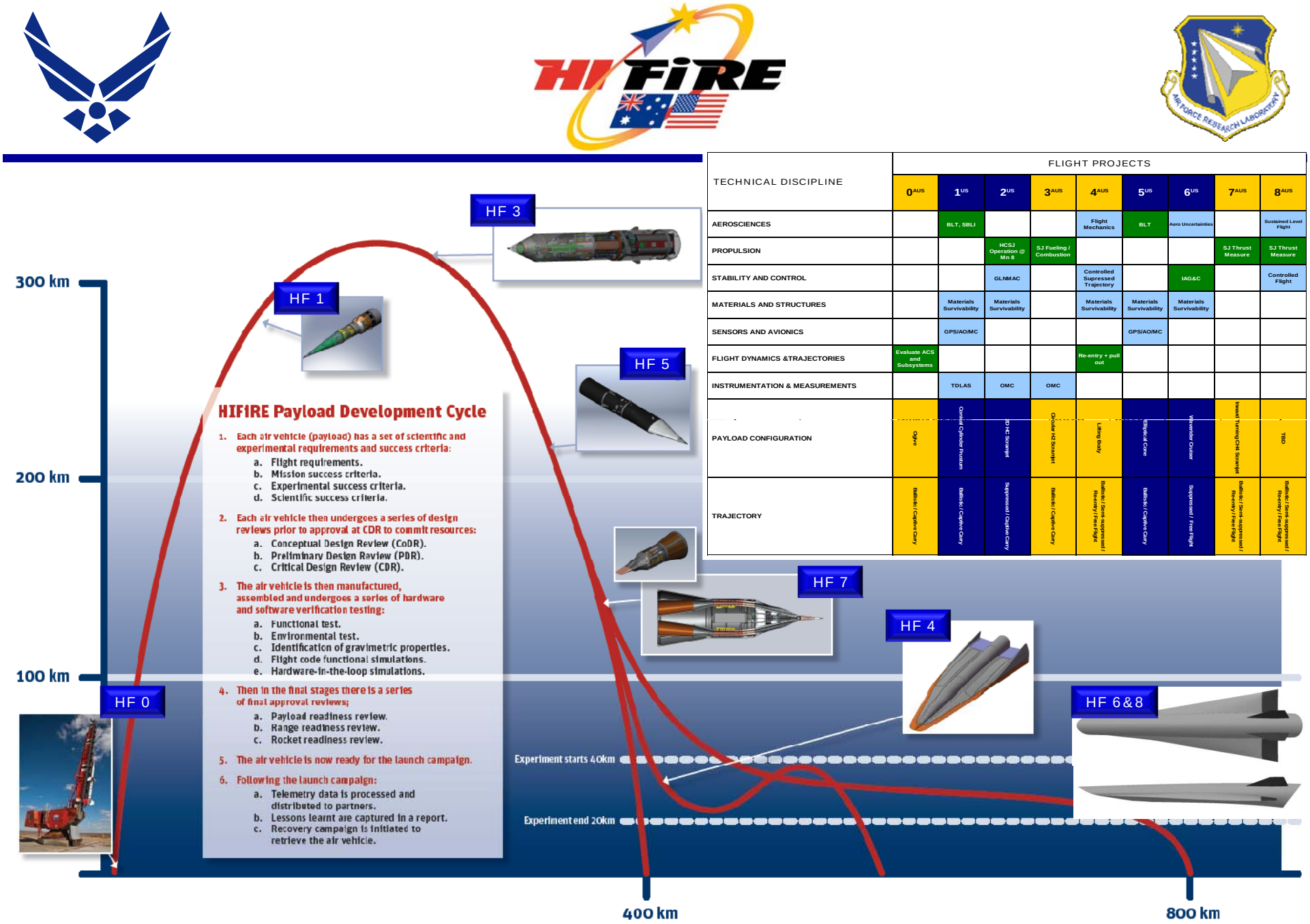
Flight test the AF Hypersonic Technology (HyTech) scramjet engine, using endothermic hydrocarbon fuel, by accelerating a vehicle from boost (~M=4.5) to Mach 6+

Pratt & Whitney
A United Technologies Company

- **Acquire ground and flight data on an actively cooled, self-controlled operating scramjet engine (rules and tools development)**
- **Demonstrate viability of an endothermically fueled scramjet in flight**
- **Prove viability of a free-flying, scramjet powered, vehicle (Thrust > Drag)**

X-51A Flight Demonstrations

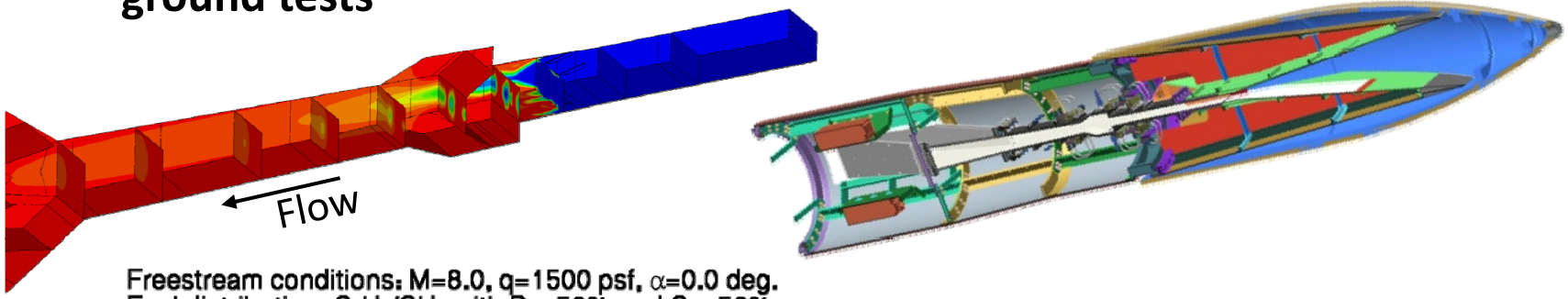
- Hydrocarbon scramjet to accelerate an air vehicle from Mach 4.5 to Mach 6+ hypersonic cruise
- Four flight vehicles fabricated
- First flight test: May 2010
  - Accelerated from Mach 4.5 to Mach 5
    - 90% of criteria met
    - Thrust, drag, and thermal performance met expectations
    - Unprecedented 143 seconds of scramjet flight data
- Second flight test: June 2011
    - Inlet unstarted during acceleration – relight attempts were unsuccessful
    - Fault Tree Analysis is guiding investigation.
- Third flight scheduled for August 2012



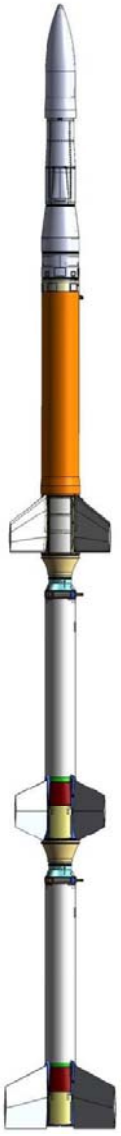
TECHNICAL DISCIPLINE	FLIGHT PROJECTS								
	0AUS	1US	2US	3AUS	4AUS	5US	6US	7AUS	8AUS
AEROSCIENCES		BLT, SBLI			Flight Mechanics	BLT	Aero Uncertainties		Sustained Level Flight
PROPULSION			HCSJ Operation @ Mn 8	SJ Fueling / Combustion				SJ Thrust Measure	SJ Thrust Measure
STABILITY AND CONTROL			GLNMAC		Controlled Supressed Trajectory		IAG&C		Controlled Flight
MATERIALS AND STRUCTURES		Materials Survivability	Materials Survivability		Materials Survivability	Materials Survivability	Materials Survivability		
SENSORS AND AVIONICS		GPS/AO/MC				GPS/AO/MC			
FLIGHT DYNAMICS &TRAJECTORIES	Evaluate ACS and Subsystems				Re-entry + pull out				
INSTRUMENTATION & MEASUREMENTS		TDLAS	OMC	OMC					
PAYLOAD CONFIGURATION	Ogive	Conical Cylinder Frustum	3D HC Scramjet	Cylular HZ Scramjet	Lifting Body	Elliptical Cone	Waverider Cruiser	Inward Turning CHI Scramjet	TBD
TRAJECTORY	Ballistic / Captive Carry	Ballistic / Captive Carry	Suppressed / Captive Carry	Ballistic / Captive Carry	Ballistic / Semi-suppressed / Re-entry / Free Flight	Ballistic / Captive Carry	Suppressed / Free Flight	Ballistic / Semi-suppressed / Re-entry / Free Flight	Ballistic / Semi-suppressed / Re-entry / Free Flight

HIFiRE Flight 2
May 2012

- **HIFiRE Flight 2 – Scramjet Operating Mode Transition**
  - **Flight test in May from Kauai, Pacific Missile Range Facility**
  - **Builds upon prior flights at Woomera (May 2009, March 2010)**
  - **Rocket-boosted acceleration to Mach 8 through air-breathing flight corridor**
  - **Flight predictions anchored by high fidelity computations and ground tests**



Freestream conditions: M=8.0, q=1500 psf, α=0.0 deg.
Fuel distribution: C_2H_4/CH_4 with B_{in}=50% and C_{in}=50%



Mission Analyses & Trade Studies

- **TRESPALS^2**

  Technologies for Responsive Precision Air-Land-Sea Strike

  – "How fast is fast enough?" for high speed weapons

- **HSMAR**

  High Speed Mission Analysis Research

  – High speed ISR & Strike platform technology challenges

- **A New Generation of Concepts & Vision Vehicles**

Benefit/Cost – Military Utility – Technology Gaps

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- High Speed Aircraft portfolio

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Survivable, High Speed Weapons
Enabling Capabilities

Long Range at High Speed

Precision Strike

Variable Ordnance Effects

Aircraft Systems
Internal bombers
External fighters

Net Enabled
In-Flight Targetable

Long Range

High Speed

Rapid, Responsive Strike in Anti-Access/Access Denied (A2/AD) Environments

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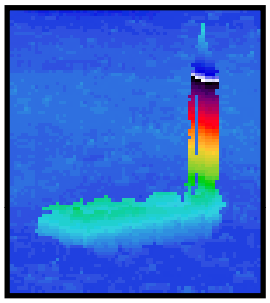
High Speed Weapon
Technology Focus Areas

Advanced Guidance for Surface Targets

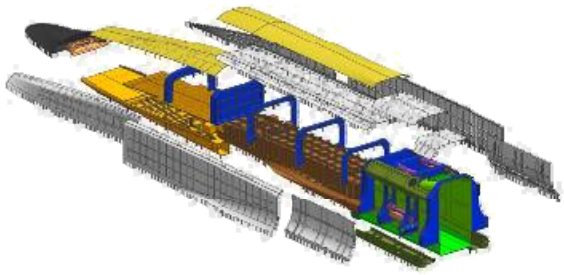


Increased Accuracy

Ordnance - Precision Selectable Effects

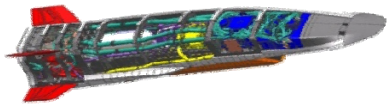
Selectable Ordnance package

High Speed Weapon Airframes



Lightweight - Low Cost

Efficient High Speed Expendable Propulsion



High Speed

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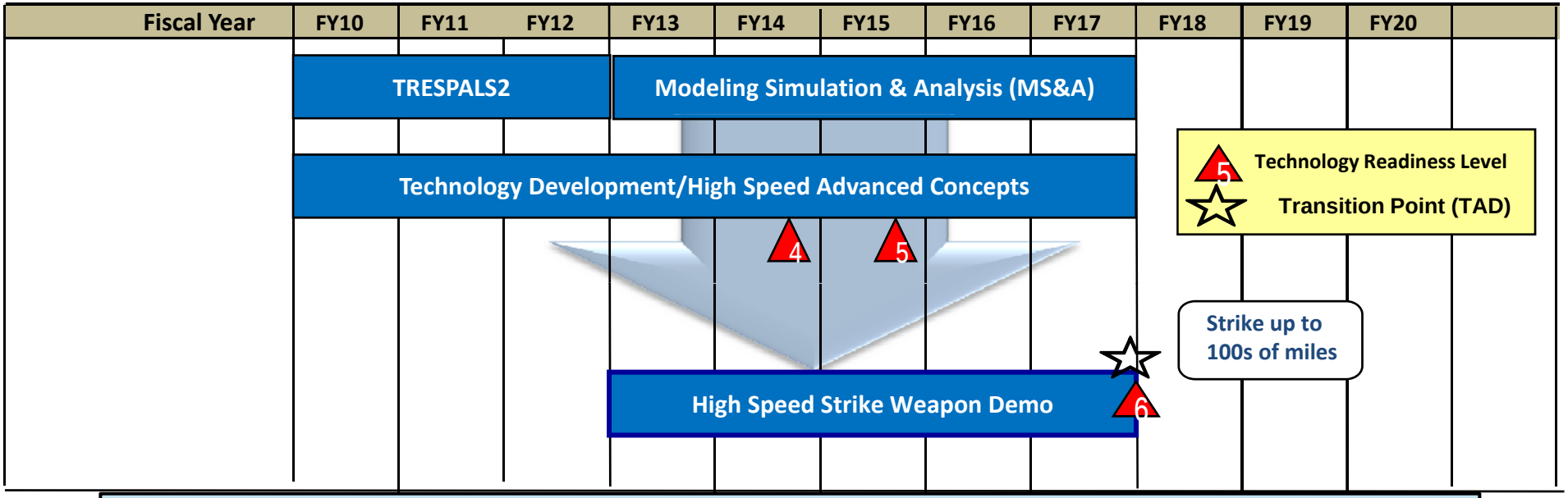
High Speed Weapon
Roadmap



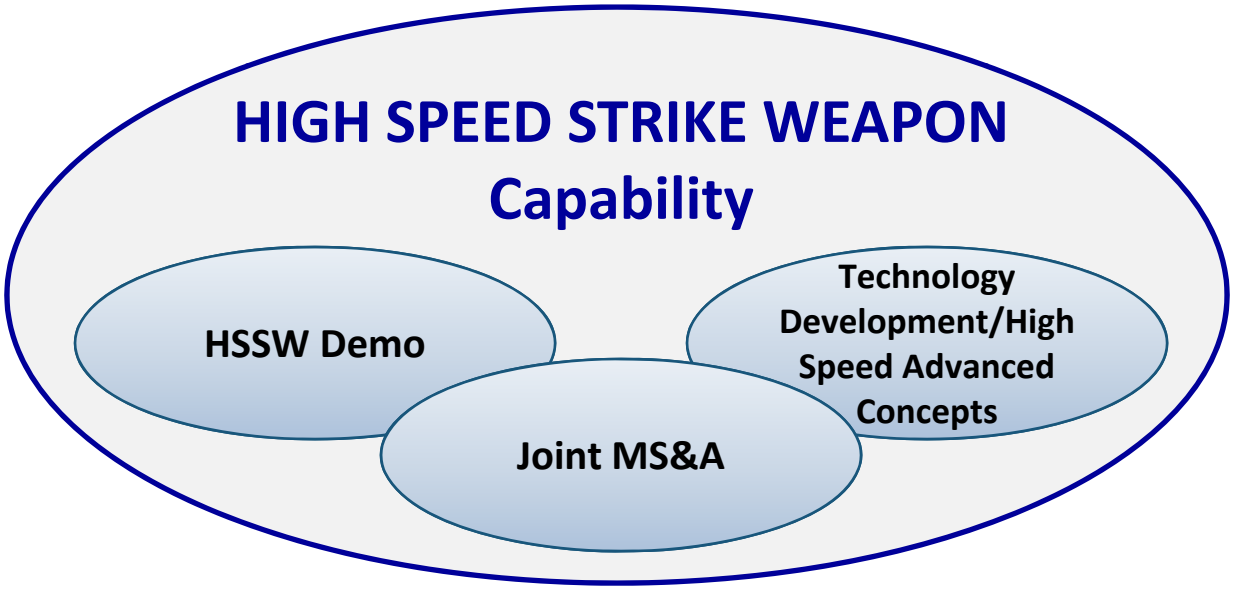
TECHNOLOGY AREAS

- High Speed Multimode Seekers
- Alternative high speed guidance (GPS denied environment)
- Ordnance Energetics
- Compact energetic booster
- Aeroconfiguration, structures and materials, control surfaces, TPS
- Compatibility with current and emerging fighters and bombers (compressed carriage)
- Low cost Manufacturing
- Compatibility with Navy/VLS

High Speed Strike Weapon
Program Architecture

Managed corporately across AFRL

– **Eglin AFB, Wright-Patterson AFB, and Edwards AFB**



Overview

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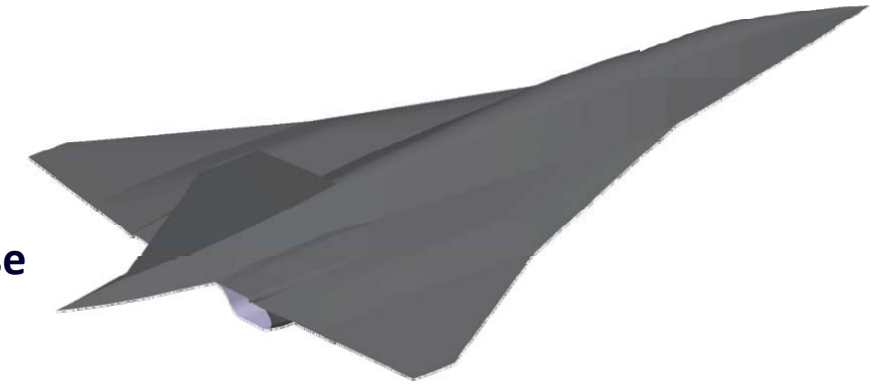
High Speed ISR/Strike
Capabilities and Attributes

Operation in A2/AD Environments

Penetrate Denied Areas (Survivable)

Large ground coverage area

"Day Without Space"



Mach 4+ Cruise

Runway Takeoff and Landing

Turbine Based Combined Cycle

Reusable, Long-Life Airframe

On-Demand Flight in A2/AD Environments

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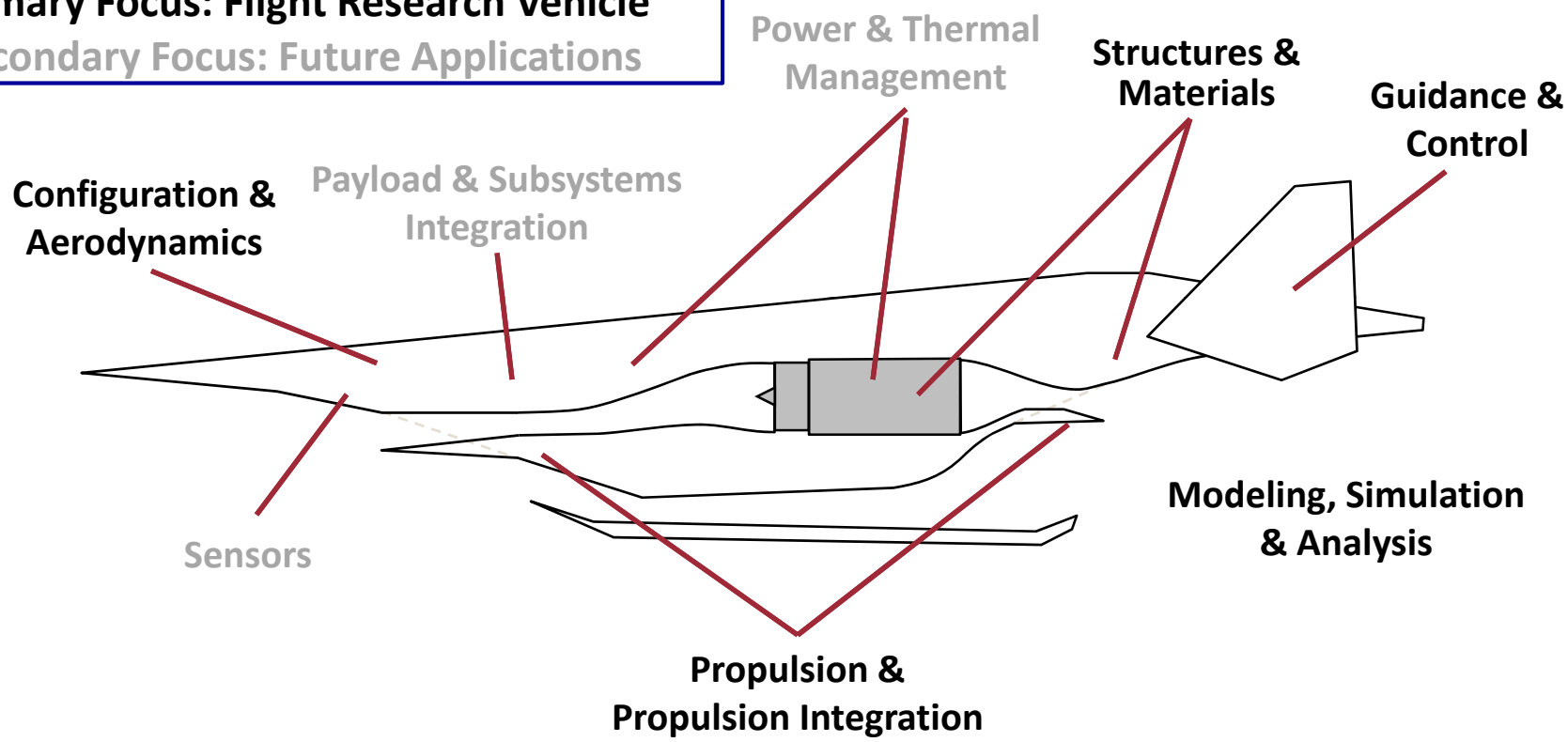
High Speed ISR/Strike
Challenges and Demonstration Objectives

- Gas Turbine-to-Dual Mode Ramjet Transition
- Mach 4+ Cruise
  - Mach 0-4+ Acceleration
  - Limited Life at Higher Mach Cruise
- Aircraft Operation
  - Takeoff, Landing, Control
- Maneuvering
- Subscale Airframe, Half or Full-Scale Flowpath
- Testbed Secondary Objectives
  - CMC Structures
  - Advanced Power/Thermal Management
  - Sensors
  - Affordability Trades and Initiatives

High Speed ISR/Strike
Technology Focus Areas

Primary Focus: Flight Research Vehicle
Secondary Focus: Future Applications



Supporting Resources for Primary Focus Areas:

MS&A: Operational Utility Analysis, Vision Vehicle, Architecture

Research Facilities: Computational, Ground, HiFIRE, Flight Research Vehicle

Summary

- **Recent Developments**
  - Steady progress towards new warfighting capabilities
- **High Speed Weapon portfolio**
  - Executable plan for technology maturation and transition
- **High Speed Aircraft portfolio**
  - Exploration and development of future capabilities