

Hypersonic Vehicle Propulsion System Simplified Model Development

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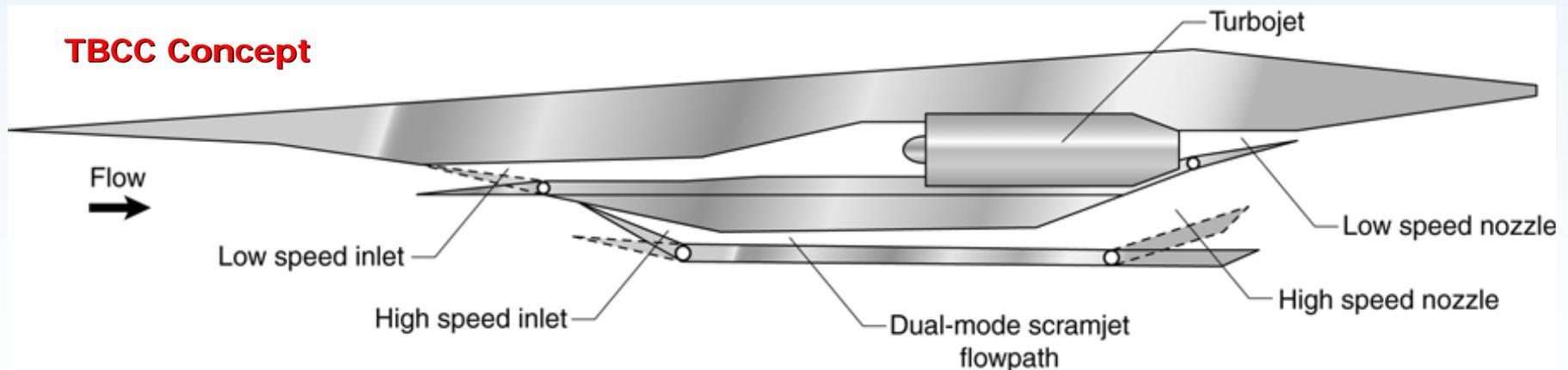
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Hypersonic Project GNC

- Interested in Controlling the Hypersonic Vehicle Propulsion system.
- Gain insights in Propulsion-Control and Flight-Control coupling issues.
- Four Basic Elements Necessary to Design Controllers:
 - Models,
 - Objectives,
 - Admissible controllers, and
 - Controller performance Metrics.
- Propulsion system primary Components:
 - Fore body compression surface,
 - Inlet,
 - Isolator
 - Combustor, and
 - Expansion Nozzle.



Albertson, C.W., Emami, S., and Trexler, C.A., "Mach 4 Test Results of a Dual-Flowpath, Turbine Based Combined Cycle Inlet," AIAA 2006-8138.

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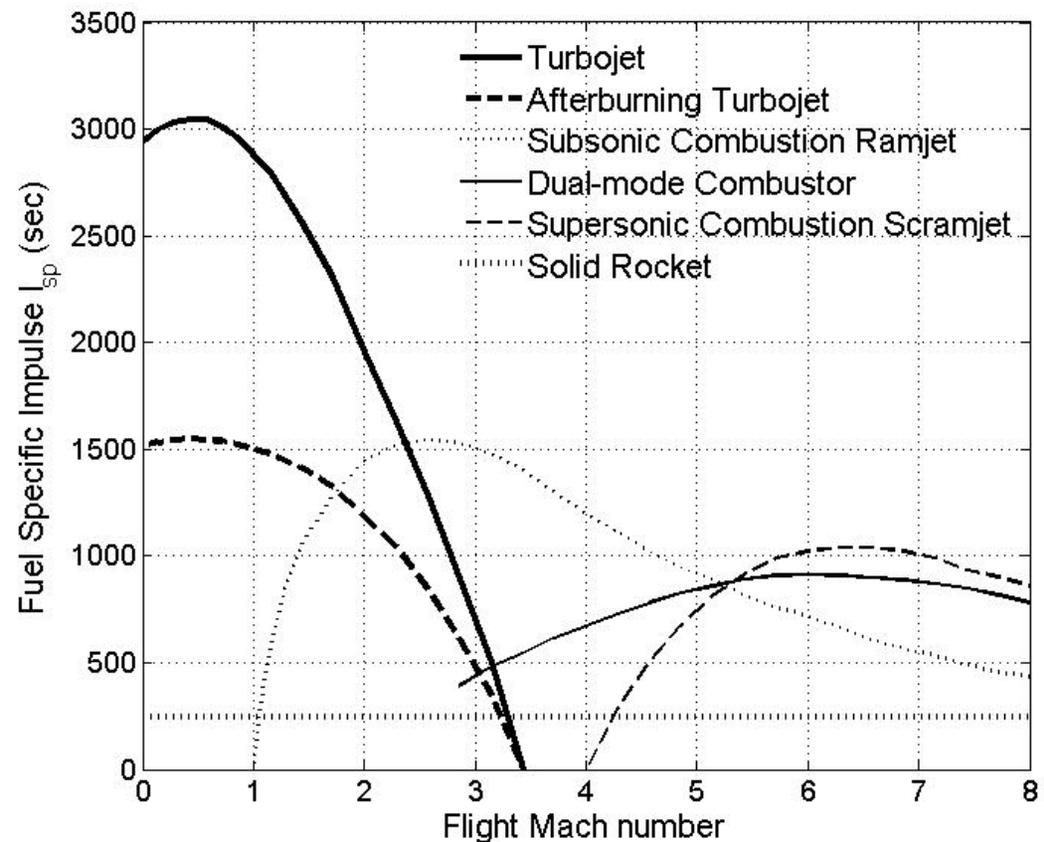
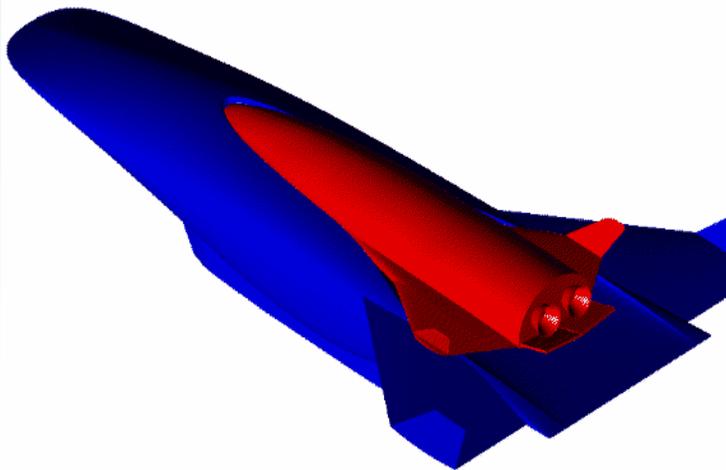


Hypersonic Propulsion System

The Vision vehicle:

- Turbojet or afterburning turbojet
- Dual-Mode Combustor

Transition from one flow path to another is a critical and enabling procedure for the hypersonic vehicle.



Billig, F.S., "Tactical Missile Propulsion," Progress in Astronautics and Aeronautics Volume 170, "Tactical Missile Design Concepts," AIAA, ISBN 1-56347-188-3, 1996.

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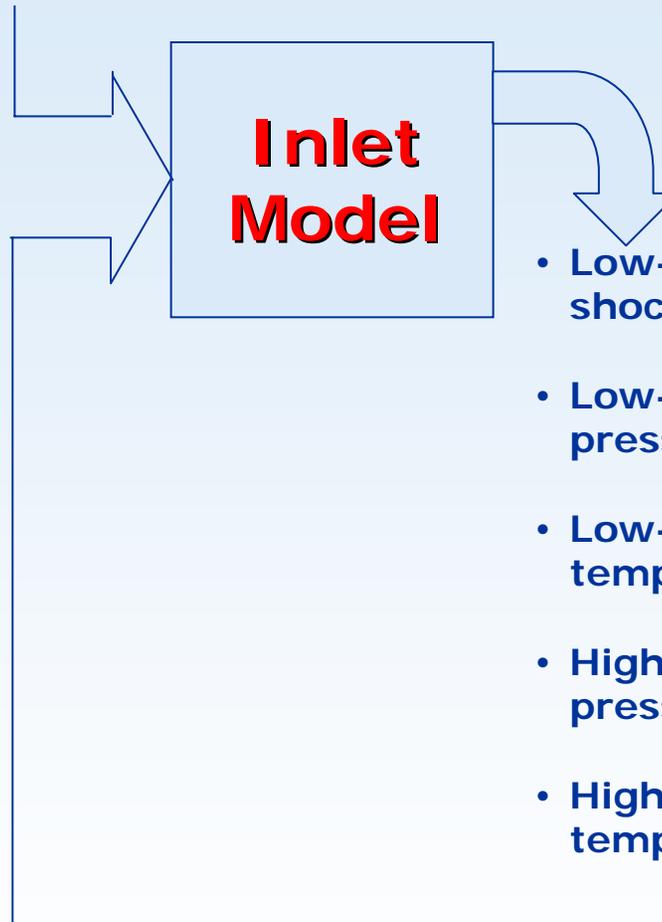
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Simplified Inlet Model Structure

- Free-stream conditions.
- Low-speed path cowl position.
- Low-speed path ramp position.
- Low-speed path bleed flow.
- Low-speed path back flow rate.
- High-speed path cowl position.
- High-speed path back flow rate.



- Low-speed path normal shock position.
- Low-speed path axial pressure distribution.
- Low-speed path axial temperature distribution.
- High-speed path axial pressure distribution.
- High-speed path axial temperature distribution.

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Analytical Resources

Electronic Resources

- LAPIN
- SRGULL

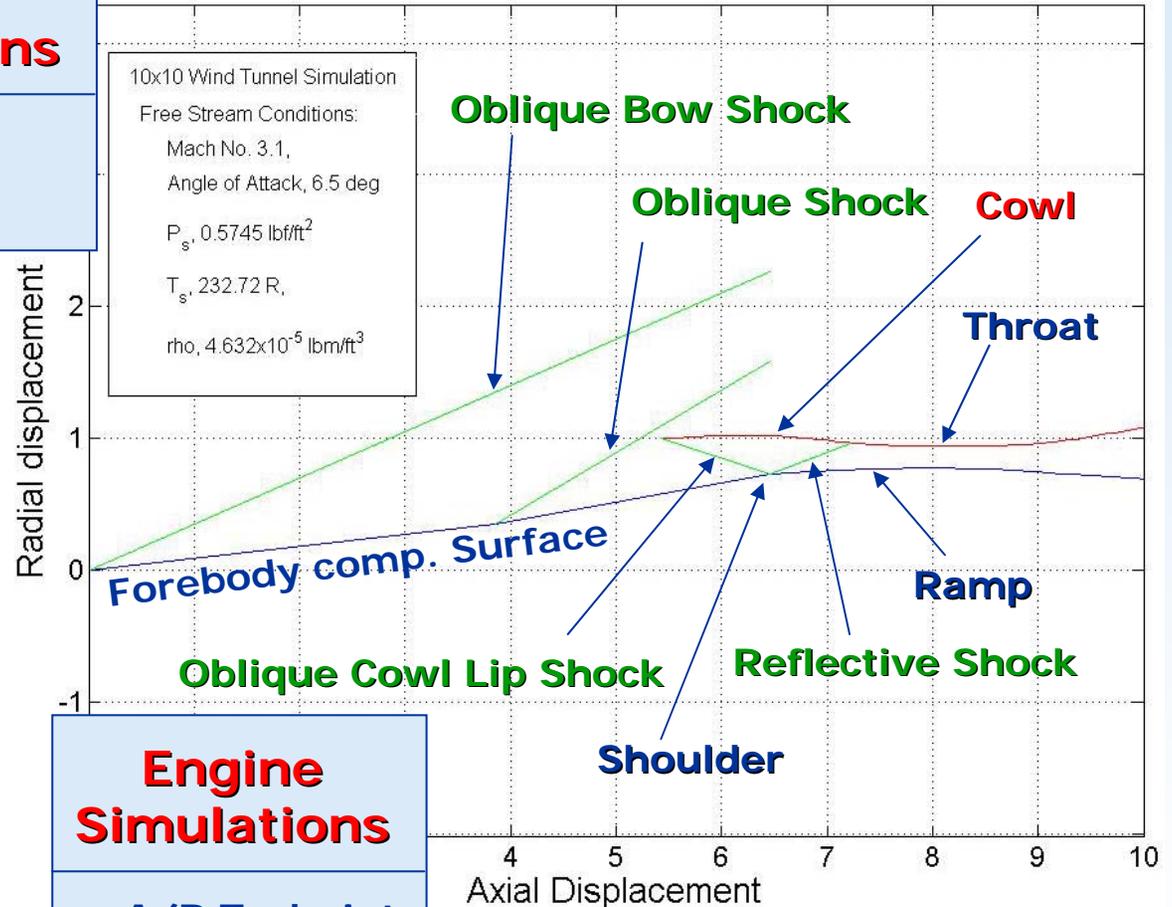
Vehicle Simulations

- GHAME
- AFRL

Supersonic Inlet Simulations

- NACA reports,
- Melcher Toolbox,
- Willoh, Cole, Melcher, and Johnson,
- Sorensen,
- Anderson,
- Pratt and Heiser,
- Chicatelli,
- Kumar,
- Pinckney, and
- Amin

L-IMX Low-Speed Flow-Path External Shock Structure



Engine Simulations

- A/B Turbojet
- SRGULL

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Propulsion Modeling Roadmap

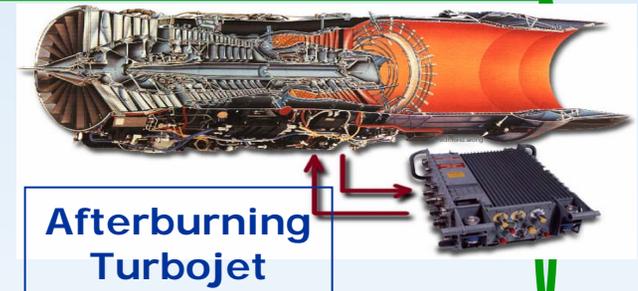
Vehicle Body

- NACA reports
- Melcher Toolbox

Procedures and Tools

- Setup,
- Run, and
- Data reduction.
- MatLab/Simulink.
- Documentation.

- Willoh, Cole, Melcher, and Johnson;
- LAPIN; and
- Amin
- CFD



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- CFD

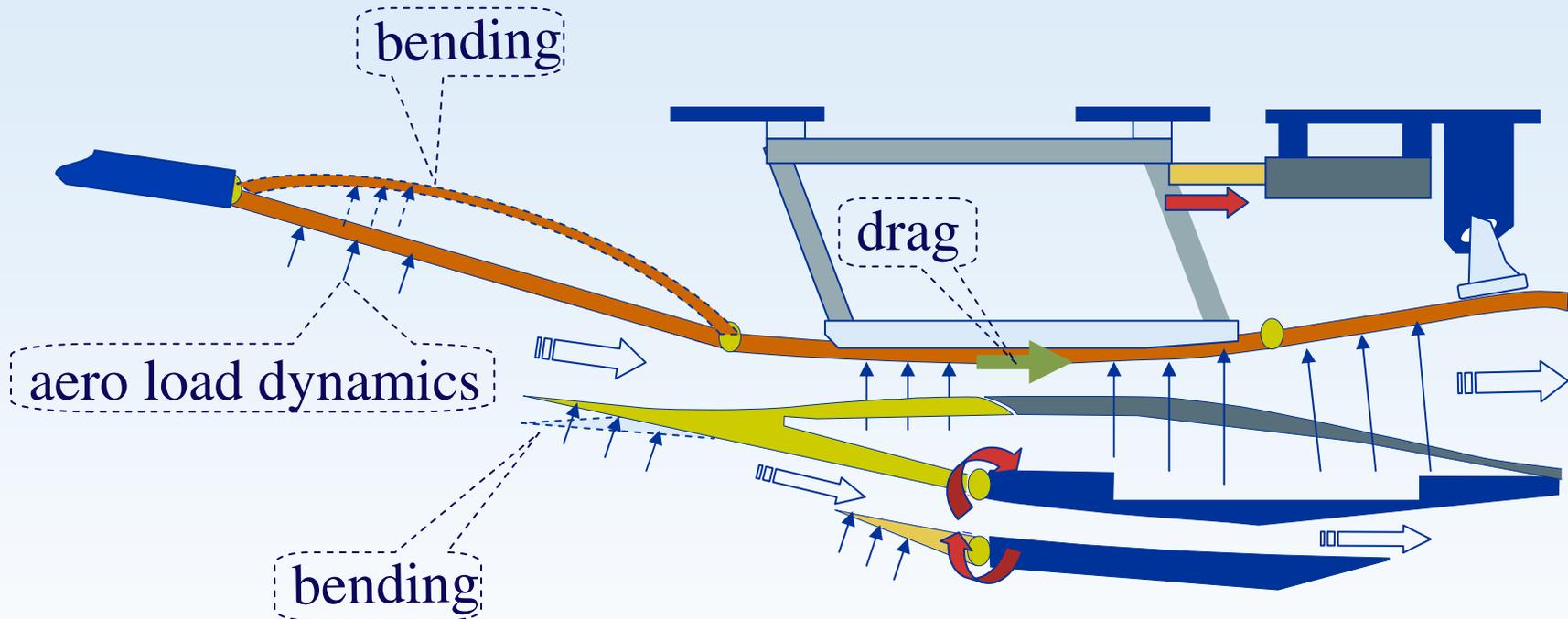
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Aero-Servo-Elasticity Aspects



Large Scale Mode Transition Inlet (L-IMX)

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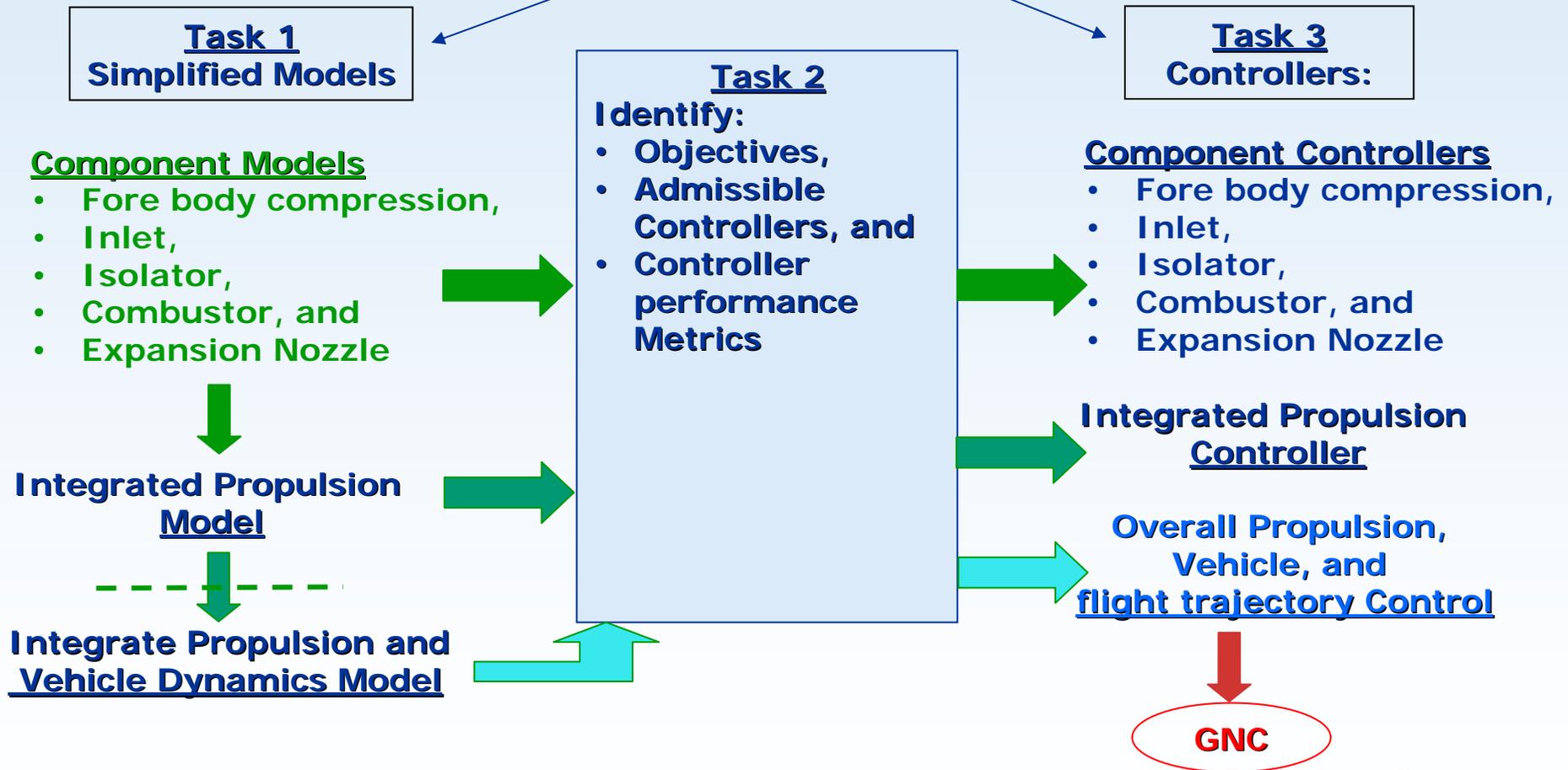
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Hypersonic Project GNC Overview

Develop Tools and Procedures



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Long Term Schedule (L-IMX)

1. L-IMX: Performance, operability, and mode transition testing.
 2. C-IMX: Control research and development.
 3. CCET: Integrated inlet system with engines.
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1. High speed flow path simulations.
 2. Low-speed flow path simulations.
 3. Simplified L-IMX computational models.
 4. Simplified engine simulations.
 5. L-IMX Schedule and Controller designed.
 6. Inlet controller coupled with engine control.

