Focus of NASA's Spaceliner 100 Investment Area

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NASA

The New World

The American West

Transcontinental Travel

Transportation . . . Opened Our Frontiers

The Dawn of Flight

International Commerce

6 1/2 Generations of Airliners in a Century

Wright Flyer (1903)

Boeing 777 (Today)

1st Generation Reusable Launch Vehicle (1981 – Today)

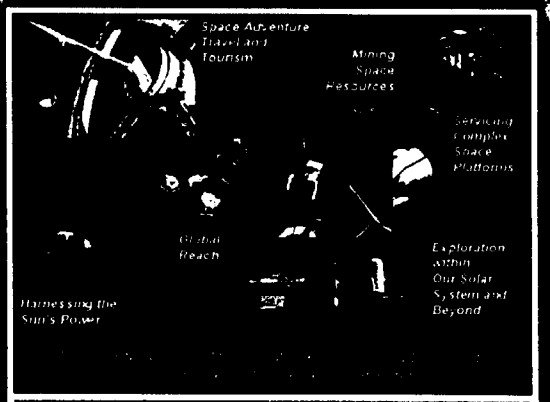
Reusable Launch Vehicles Evolutionary Path

Today: Space Shuttle
1st Generation RLV

- Orbital Scientific Platform
- Satellite Retrieval and Repair
- Satellite Deployment

2010: 2nd Generation RLV

- Space Transportation
- Rendezvous, Docking
- Crew Transfer
- Other on-orbit operations
- ISS Orbital Scientific Platform
- 10x Cheaper
- 100x Safer



2025: 3rd Generation RLV
(Spaceliner 100)

- New Markets Enabled
- Multiple Platforms/Destinations
- 100x Cheaper
- 10,000x Safer

2040: 4th Generation RLV

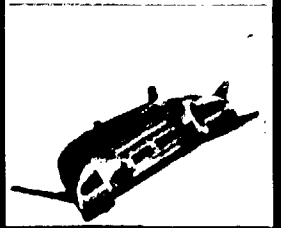
- Routine Passenger Space Travel
- 1,000x Cheaper
- 20,000x Safer

SL100 Technology Focus

Goals

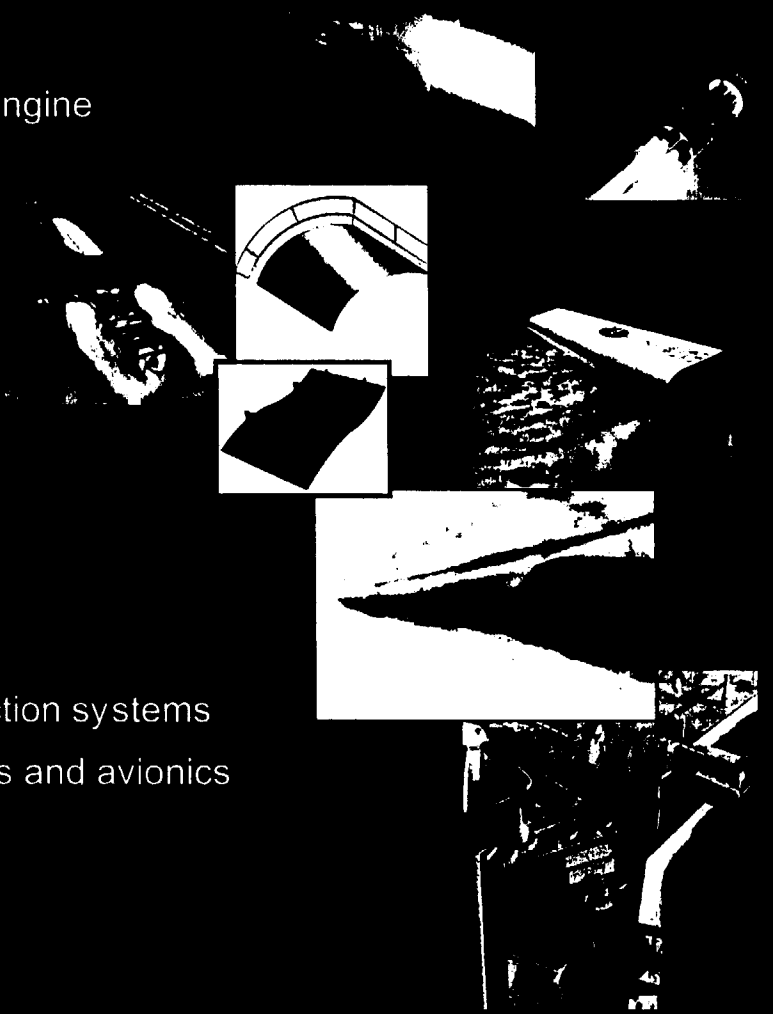
100x Cost Reduction & 10,000x Safety Increase by 2025

Technology Objective	Challenge
Increase System Performance Margin	Increased Engine Thrust/Weight Increased Mission Specific Impulse Improve Mass Fraction Increased Range (Cross and Down)
Drive Down Operations Costs	Increased Margin Increased Reliability Increased Life Increased Vehicle Health/ State Knowledge Reduced Labor Reduced Processing Reduced Facilities/GSE Reduced Maintenance
Drive Down Manufacturing and Production Costs	Reduced Facilities Reduced Tooling Reduced Material Cost Reduced Labor
Drive Down Design, Development, Test and Evaluation Costs	Reduced Design Cycle Time Reduced Weight Reduced Complexity Increased Technology Readiness Level @ Insertion

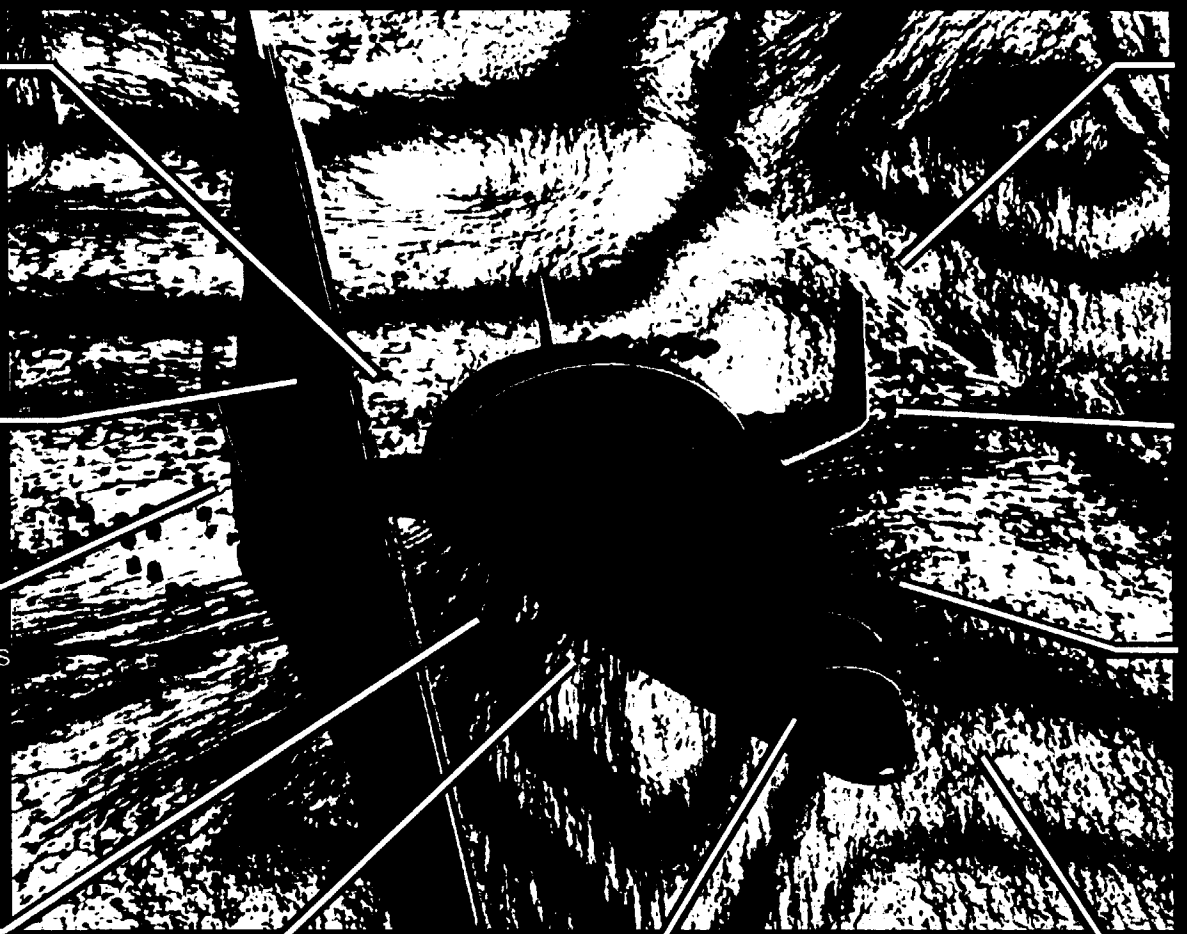


3rd Generation Technology Drivers

- **Dramatic Propulsion Performance Improvement**
  - RBCC/TBCC - Dual Mode Ramjet/Scramjet
  - Pulse Detonation Rocket Engine/Combined Cycle Engine
  - 500 mission propulsion component life
  - Magnetic Launch Assist
- **Low Drag aerodynamic structures**
  - SHARP ultra-high temperature ceramics
  - Integrated smart/adaptive thermal-structures
  - Morphing structures
  - Drag modulation through electromagnetics and flow physics
- **Adaptive Intelligent Systems**
  - Adaptive, self-diagnosis, self-healing thermal protection systems
  - Structurally integrated, wireless, micro/nano sensors and avionics
  - Regenerative sensors and system healing
  - Autonomous, adaptive control
- **Spaceport Range Operations**



Space Transportation Across NASA



Ames Research Center
- Non-Metallic Thermal Protection Systems
- Computational Tools
- IVHM

Stennis Space Center
- Propulsion Testing

Kennedy Space Center
- Spaceport Operations
- Range Safety
- Launch Assist

Dryden Flight Research Center
- Atmospheric Flight Operations

Johnson Space Center
- Crew and Passenger Systems

Langley Research Center
- Integr Airframe Design
- Integrated Thermal Structures
- Materials Research
- TPS
- Aero/Aerothermal Enh.

JPL
- Microelectronics/ Sensors

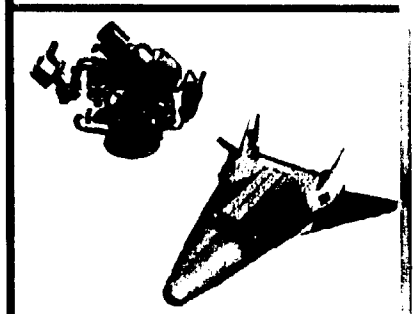
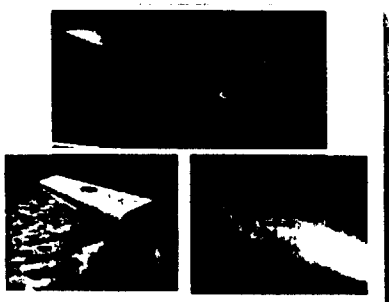
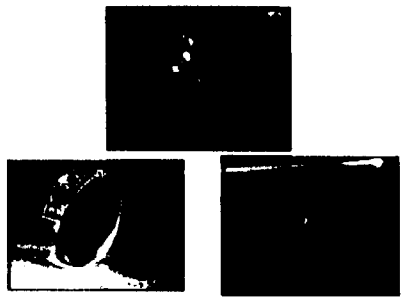
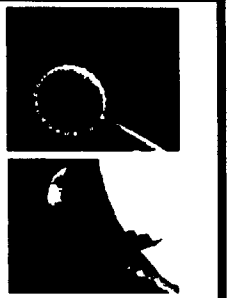
Glenn Research Center
- Power Systems
- Advanced Propellants
- Propulsion Materials
- Combined-Cycle Propulsion Flowpaths

Air Force Research Lab

Marshall Space Flight Center (Lead Center)
- System Integration
- Propulsion Systems
- Avionics Systems
- Combined-Cycle Propulsion Demo
- Vehicle Definition
- Structural and Mechanical Design and Integration
- Advanced Manufacturing

ASTP Program Overview

Organization Based Around 4 Investment Areas

	Pillar 2			
					
Objective	Earth-to-Orbit	Earth-to-Orbit	In-Space	Discovery Driven
Investment Area	2nd Generation RLV	Spaceliner 100	In-Space	Space Transportation Research
Projects	RLV Focused	Propulsion Tech & Integ. Operations & Range Propulsion Research & Tech Launch Vehicle Airframe IVHM	Space Transfer Technology Interstellar Precursor	Space Propulsion Breakthrough Physics

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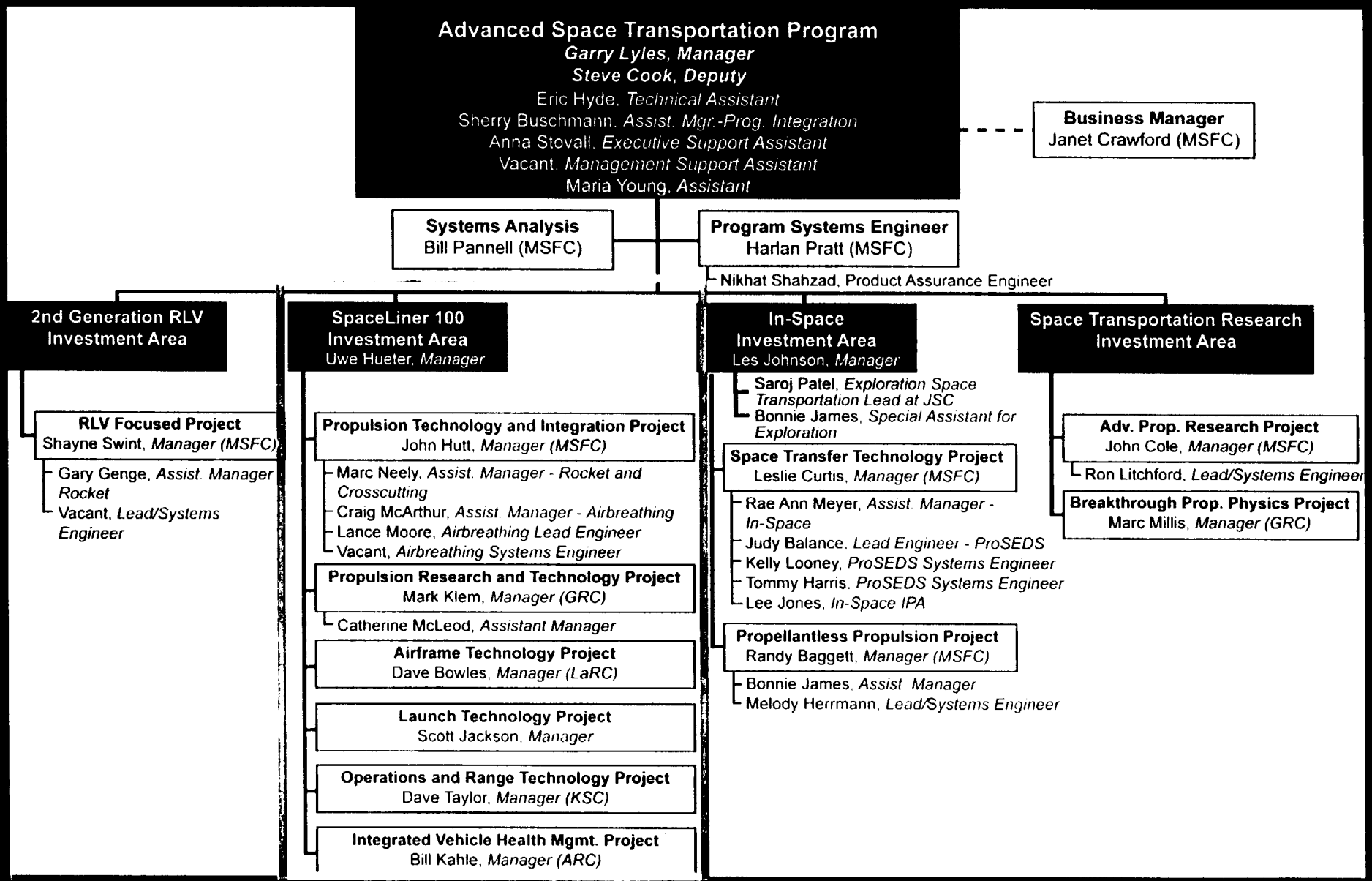
Funded by 2nd Generation RLV Program

Multi-Center Team



Propulsion Projects

- **Aibreathing Propulsion**
  - Rocket-Based Combined Cycle (RBCC)
  - Turbine-Based Combination Cycle (TBCC)
  - Pulse Detonation Engine (PDE) Combined Cycle
  - Technology Test Bed
- **Rocket Propulsion**
  - High Thrust-to-Weight/Long-life Advanced Rocket Engines
  - Turbo-rockets
  - Pulse Detonation Rocket Engine (PDRE)
  - Technology Test Bed
- Cross-cutting Technologies
  - Tools for Design & analysis
  - Materials
  - Turbomachinery, Combustion Devices, Nozzles, Valves
  - Instrumentation

Airframe Project

- **Integrated Airframe Design**
  - Tools for Rapid Design & Analysis-Including Safety, Uncertainty
- **Integrated Thermal Structure & Materials**
  - PMC s, Insulation, Sealants & Manu f
  - Metal & MMC Structures, Mat ls & Manu f for Hot structures & Cryotanks
  - CMC for Integrated Airframe Structures
- **TPS**
  - Adaptive Intelligent, Emergency and Acreage TPS
  - Multifunctional Metallic Integrated TPS/Aeroshell
  - Superthermal Insulation TPS
  - Ultra-high Temperature Sharp Leading Edges
  - Advanced Control Surfaces Seals
- **Aero/Aerothermal Enhancements**
  - Revolutionary Flow Control Through Plasma Aerodynamics
  - Aerodynamic Morphing

IVHM Project

Informed Maintenance

Smart Self-Healing Sensor System

Self-Learning, Self-Healing Systems

Launch Systems Project

Avionics & Flight Control

- High Performance GN&C
- Advanced Evolvable Hardware
- Scalable, Fault Tolerant Intelligent Network of Transducers
- Robust, Low Cost Avionics Architecture

Power

- Advanced Electric Actuation Devices & Subsystem Technologies
- Hybrid Power Source
- High Power, High Temperature Power Electronics
- Intelligent Internal Thermal Control

Operations & Range Project

Spaceport Range

Autonomous Flight Safety System

Ground Operations

Spaceport Operations

Launch Assist


• Small Ground Crews
• Minimum Inspections and Overhauls
• Containerized Payloads
Environmentally
Friendly Fluids & Gases
Towards Airline-Like Operations
5667-14

ASTP Accomplishments

- Advanced MMC rocket thrust cell chamber fabricated at MSFC

- Completed over 2000 2-D unsteady CFD runs for optimization of turbine performance at MSFC. Gained 10 points of efficiency at design conditions over standard design practice baseline.

- Development of an Automated Tape Placement Device (ATP) with attached E-Beam Gun for ply-by-ply, cure on the fly fabrication capabilities of E-Beam curable resins.

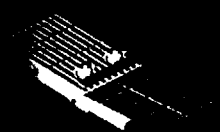
- Successfully manufactured two PMC LH2 ducts using the MSFC hand lay-up method. These ducts have passed ambient proof tests to 150 psi.

- Rocketdyne RBCC A-5 engine logged over 1 hour of accumulated test time at GASL

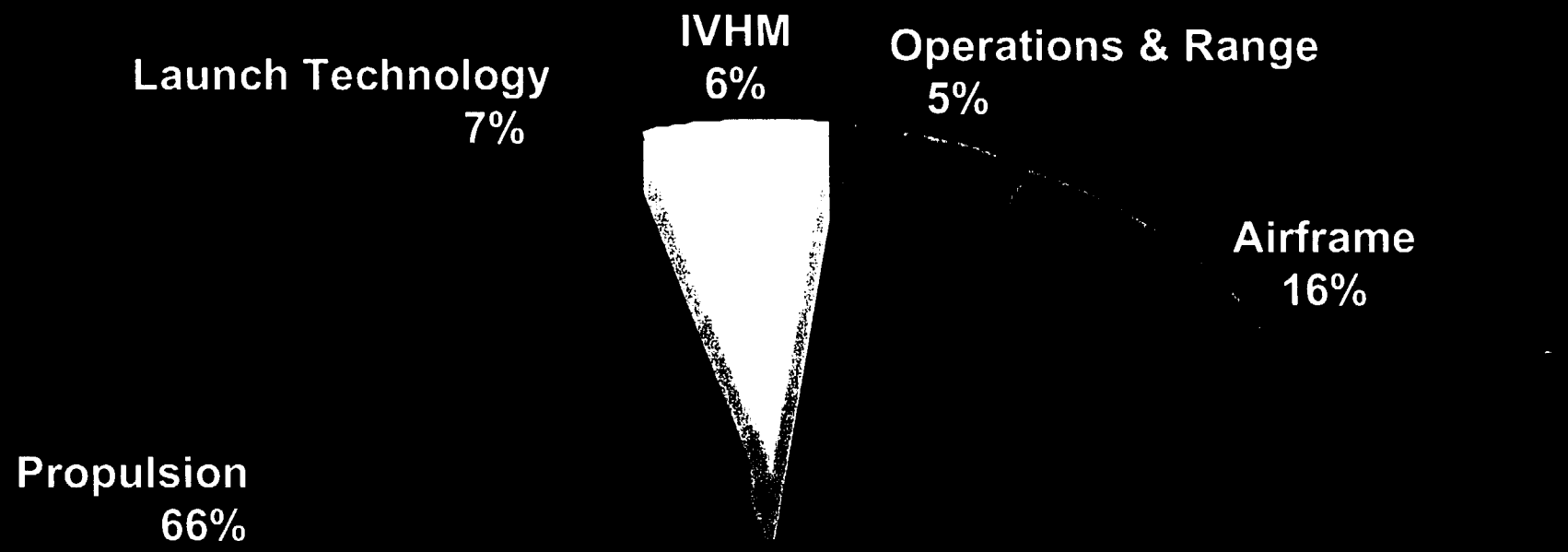
- Completed assembly and initiated testing on LOX densification unit at GRC

- Successfully hot-fired the TRW Ultra-Low Cost Engine (Pintle) at SSC

- Rocketdyne, Pratt and Whitney and Aerojet formed a consortium for RBCC



6 Year SL-100 Budget Distribution



Major Milestones

- SRR for 1st Airbreathing Demonstrator in FY01
- Initial Release of 0-D Propulsion System Simulation in FY01
- Demonstrate Resin Transfer Molded PMC with 550ßF Use Temp in FY02
- Develop Advanced Adhesives for Non-Autoclave Processing in FY02
- Submit Proposal for A/B Flight Demonstrator in FY03
- First test of A/B Demonstrator Engine System in FY04
- First A/B Flight Demonstrator in FY06

SL100 Investment Area Summary

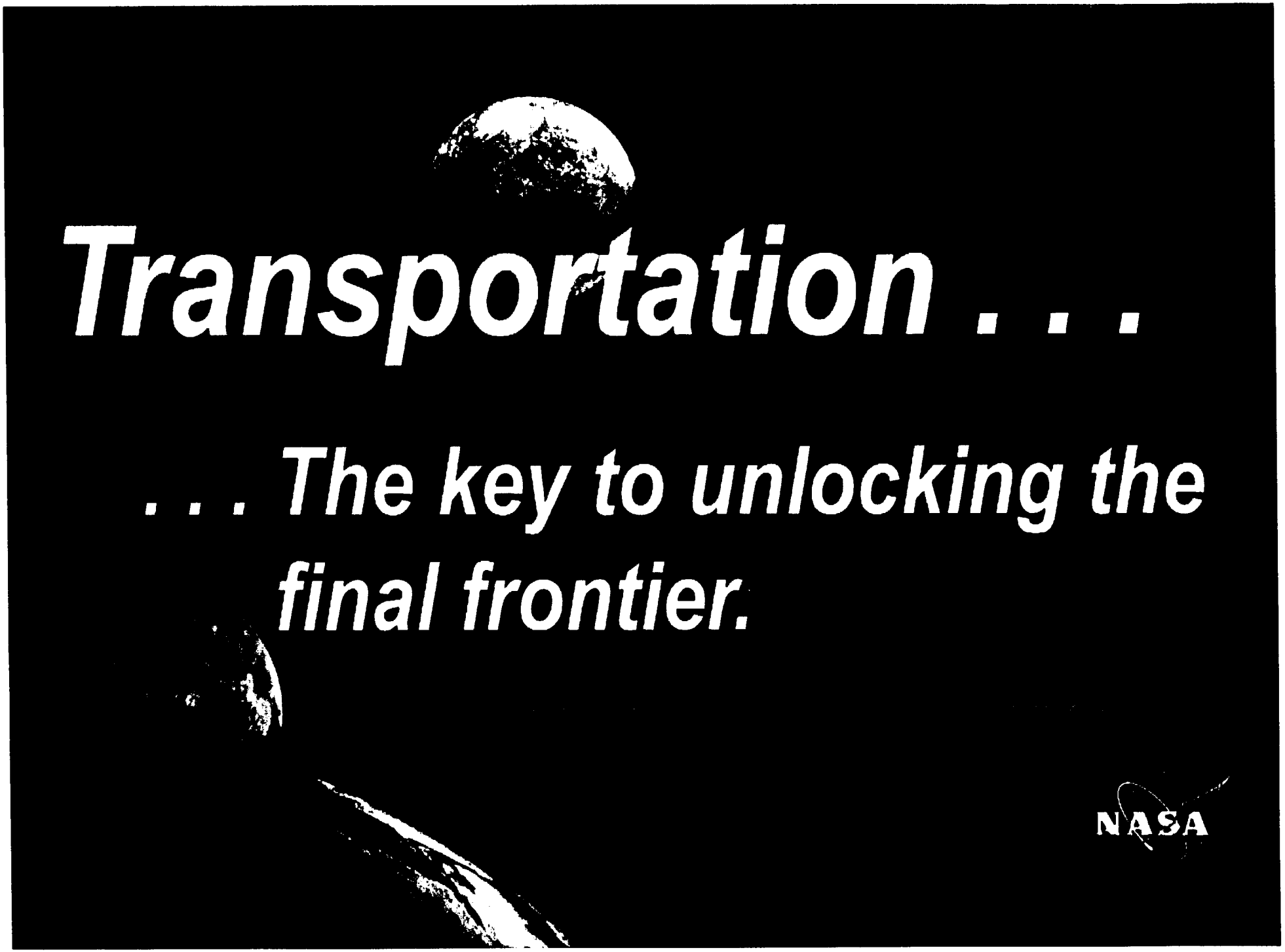
Not A Vehicle, But An Investment Approach To Mature Technologies To Achieve The Following Goals

- Reduction In Launch Cost By A Factor Of 100
- Improvement In Safety By A Factor Of 10,000
- Operational Around 2025

Technology Development Activity

- Propulsion
- Airframe Systems
- IVHM
- Launch Systems
- Operations & Range

Keep Options Open As Long As Technologies Continue To Show Feasibility


Transportation . . .
. . . The key to unlocking the final frontier.
NASA