




LOW EMISSIONS ALTERNATIVE POWER (LEAP)

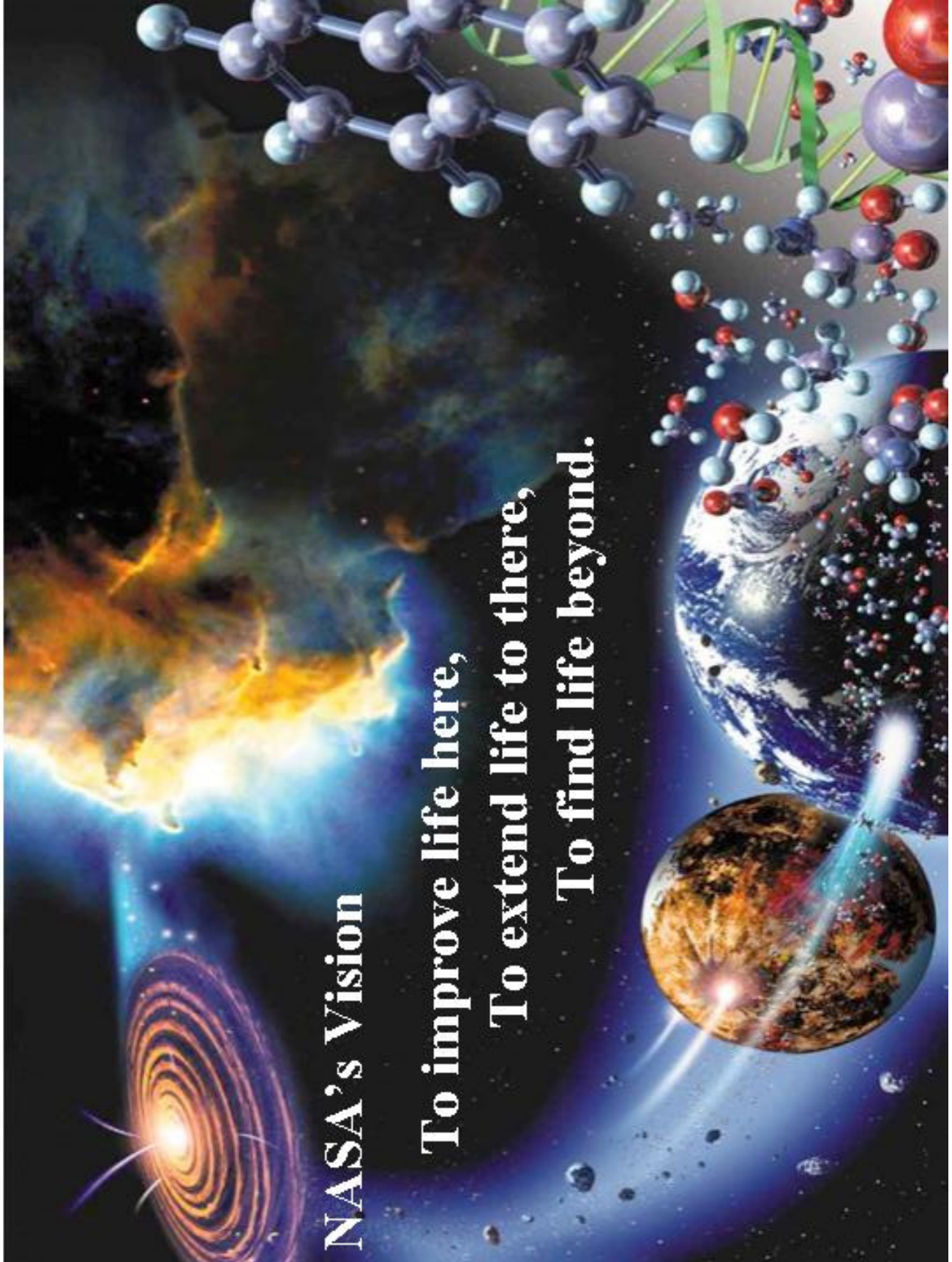
Gary T. Seng
National Aeronautics and Space Administration
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Cleveland, Ohio



**Low Emissions Alternative Power
(LEAP)**

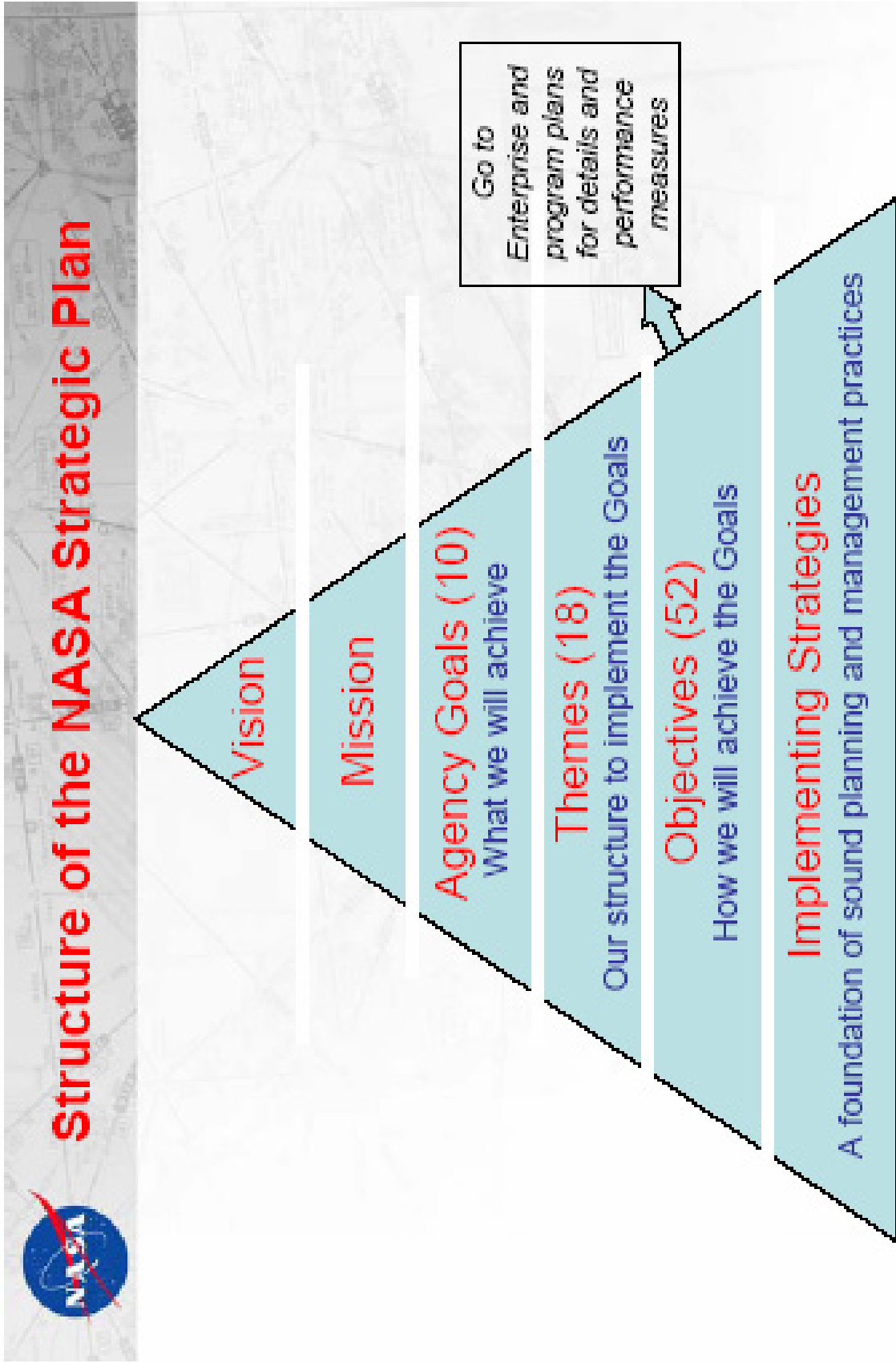
Dr. Gary T. Seng

**Seal/Secondary Air System Workshop
November 5, 2003**

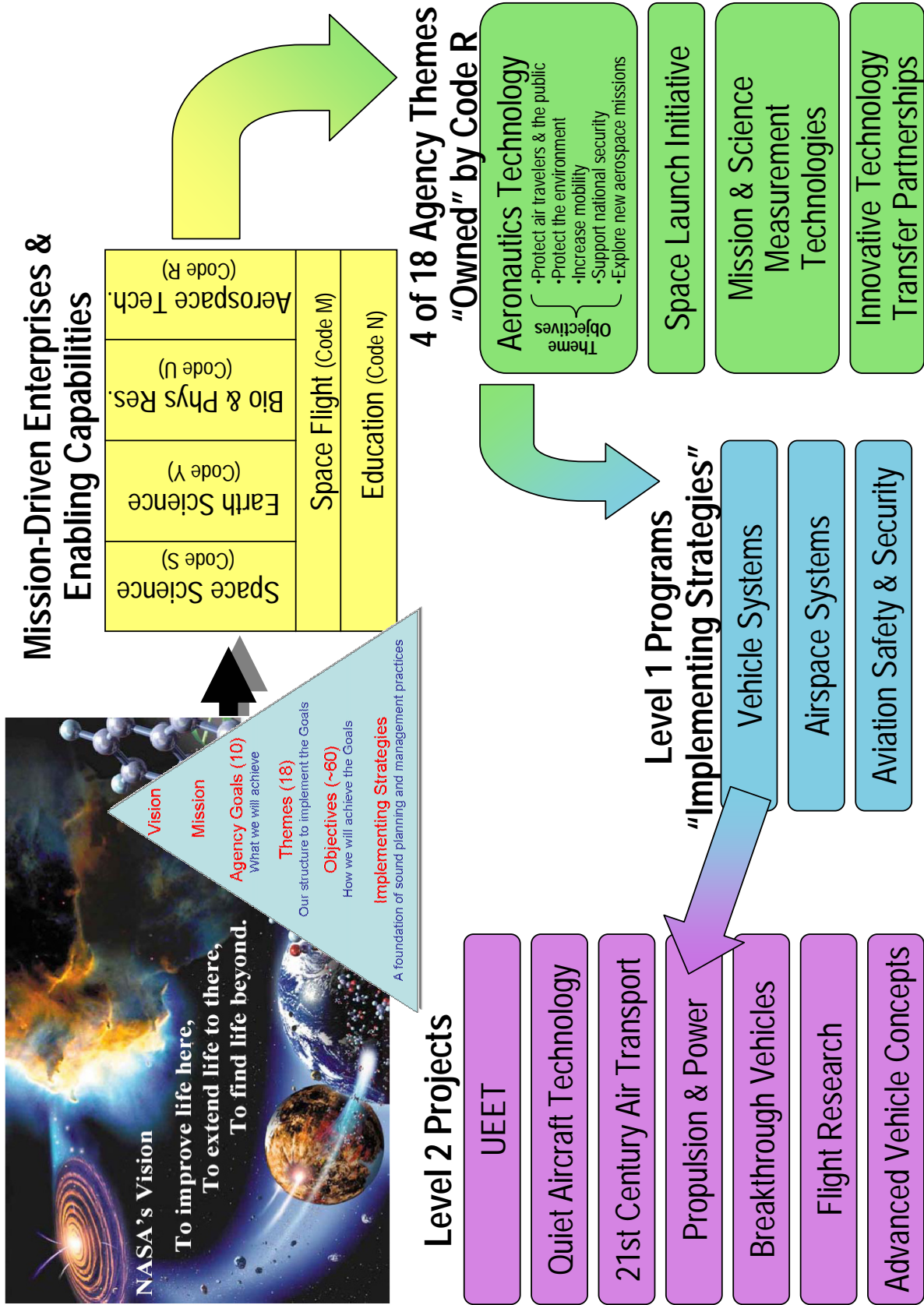


NASA's Vision

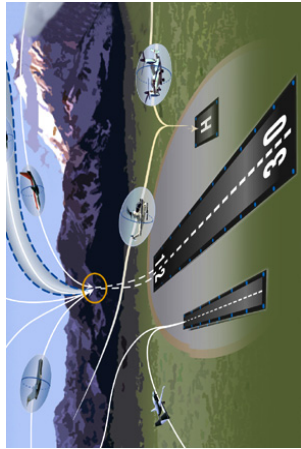
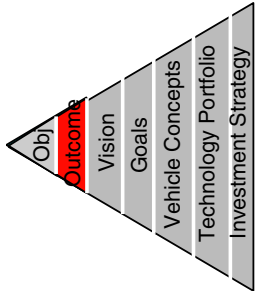
**To improve life here,
To extend life to there,
To find life beyond.**



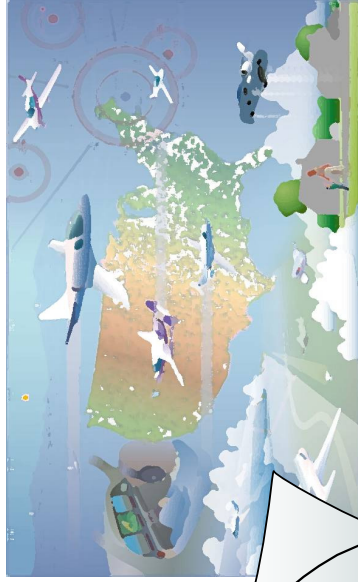
NASA Strategic Structure -- From Strategic Plan to Programs (FY03)



Aeronautics Technology – Three Integrated Programs

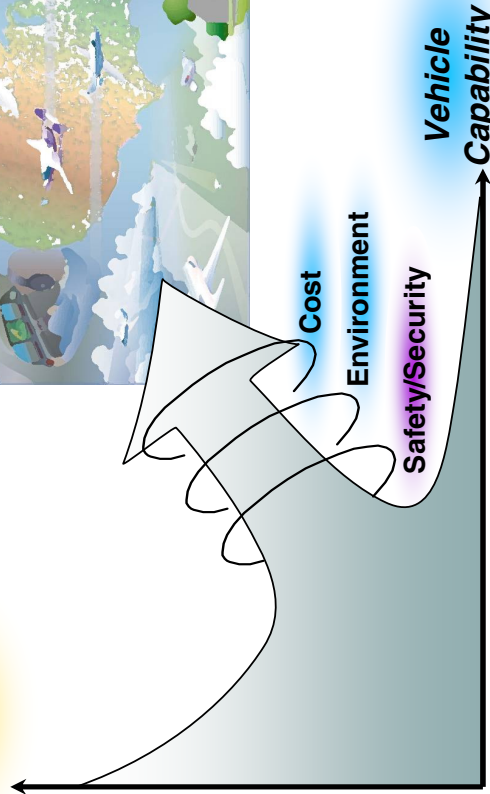


Airspace Systems



Vehicle Systems

**Airspace
Capability**

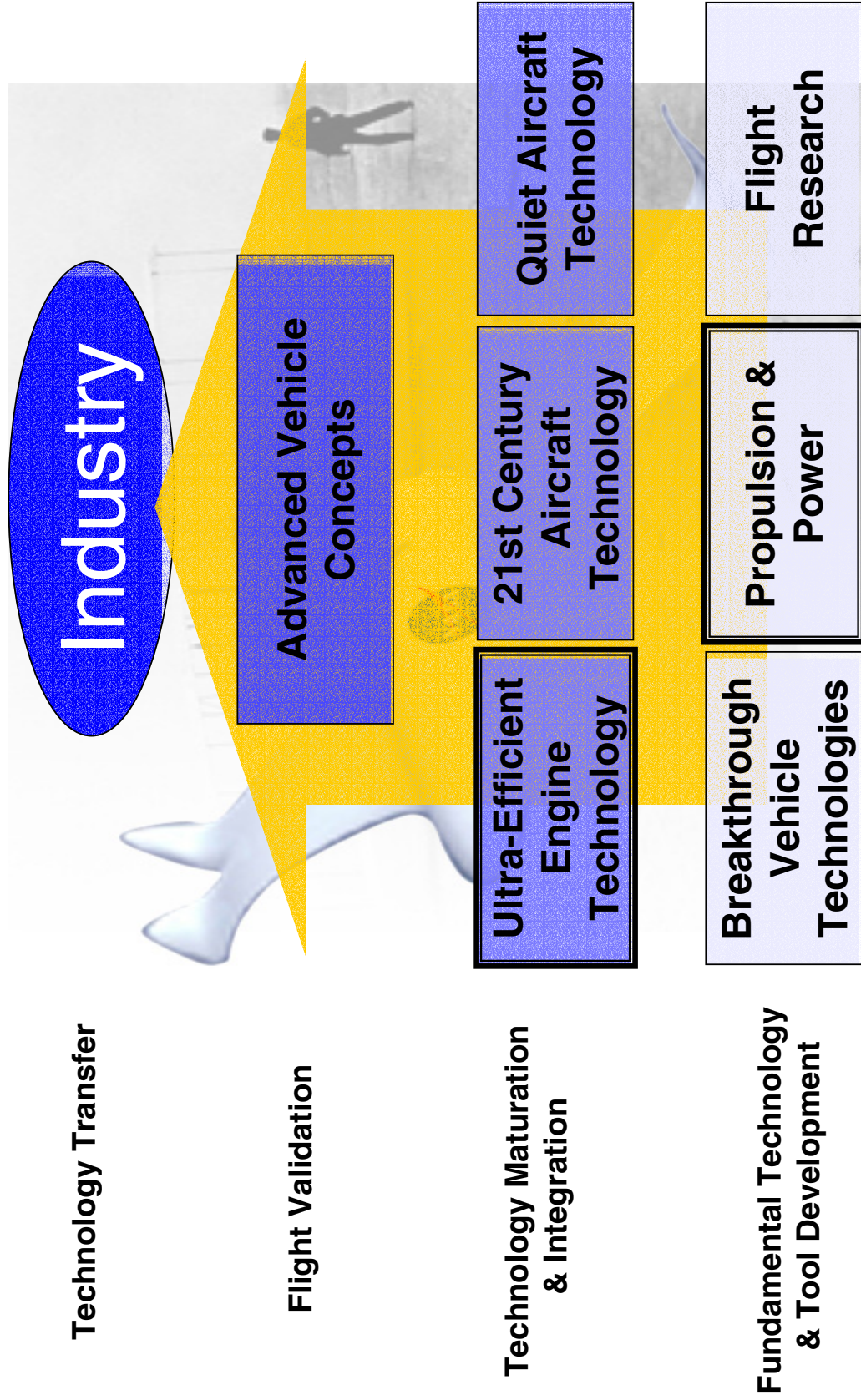


Aviation Safety & Security



Vehicle Systems

Vehicle Systems Program (FY03)



Strategic Technology Focus Areas



Six long-term technology focus areas

- Key long term investment areas
- Primary places where technology advances will occur
- Projects achieve finite steps within these areas

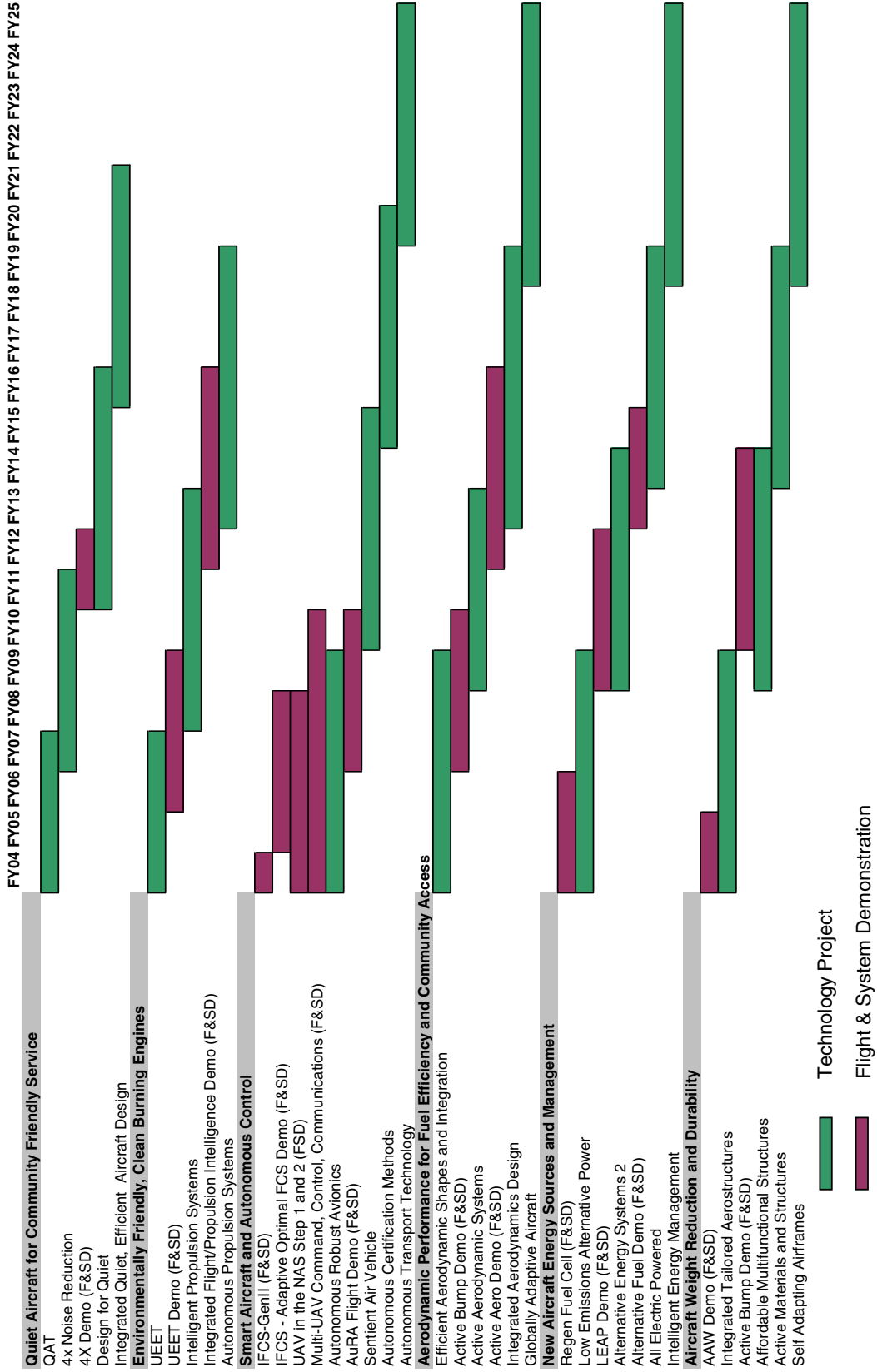
- **Environmentally Friendly, Clean Burning Engines**
Focus: Develop innovative technologies to enable intelligent turbine engines that significantly reduce harmful emissions while maintaining high performance and increasing reliability
- **New Aircraft Energy Sources and Management**
Focus: Discover new energy sources and intelligent management techniques directed towards zero emissions and enable new vehicle concepts for public mobility and new science missions
- **Quiet Aircraft for Community Friendly Service**
Focus: Develop and integrate noise reduction technology to enable unrestricted air transportation service to all communities

Strategic Technology Focus Areas (contd)

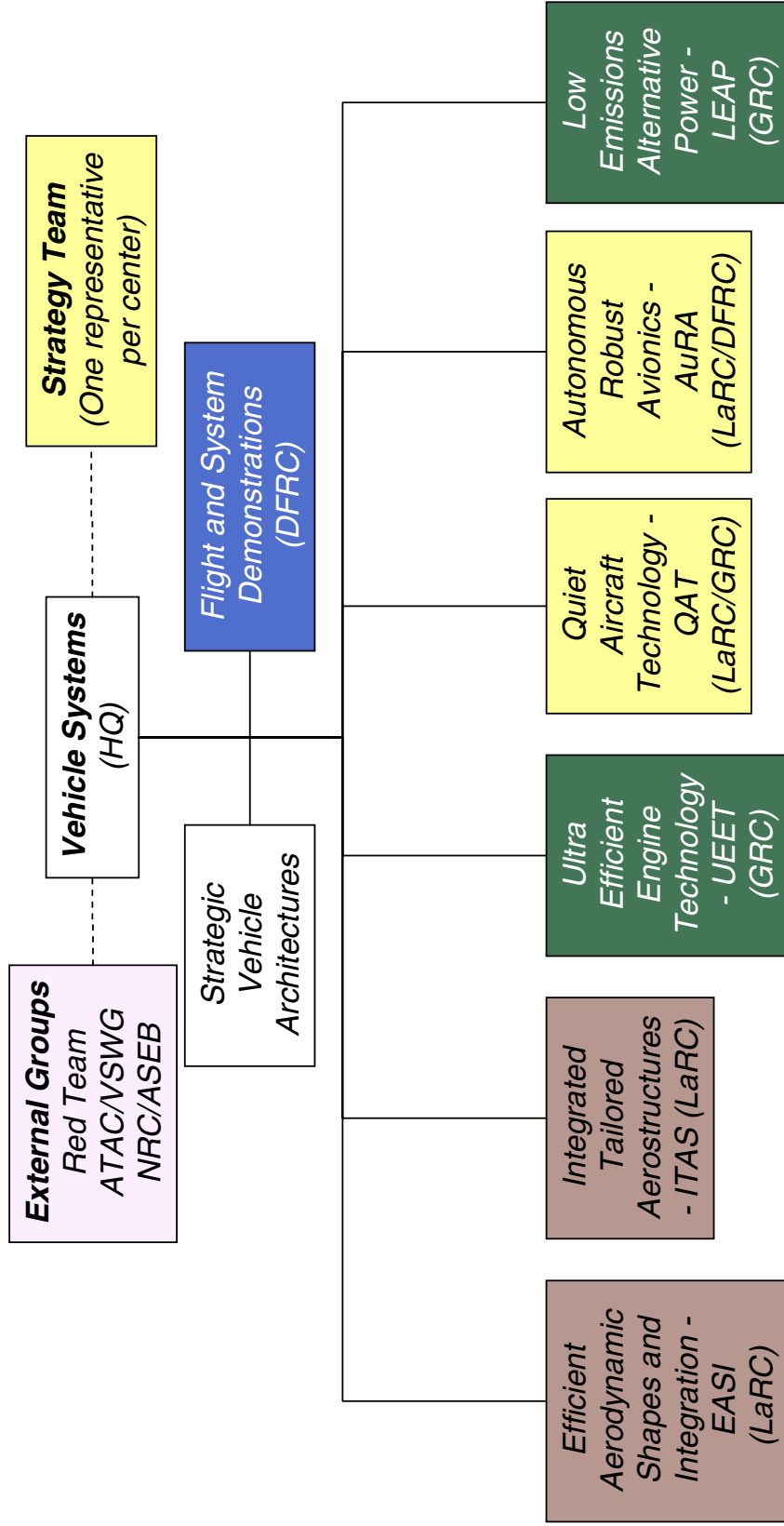


- **Aerodynamic Performance for Fuel Efficiency**
Focus: Improve aerodynamic efficiency, structures and materials technologies, and design tools and methodologies to reduce fuel burn and minimize environmental impact and enable new vehicle concepts and capabilities for public mobility and new science missions
- **Aircraft Weight Reduction and Community Access**
Focus: Develop ultralight smart materials and structures, aerodynamic concepts, and lightweight subsystems to increase vehicle efficiency, leading to high altitude long endurance vehicles, planetary aircraft, advanced vertical and short takeoff and landing vehicles and beyond
- **Smart Aircraft and Autonomous Control**
Focus: Enable aircraft to fly with reduced or no human intervention, to optimize flight over multiple regimes, and to provide maintenance on demand towards the goal of a feeling, seeing, sensing, sentient air vehicle

Vehicle Systems Strategic Focus Areas

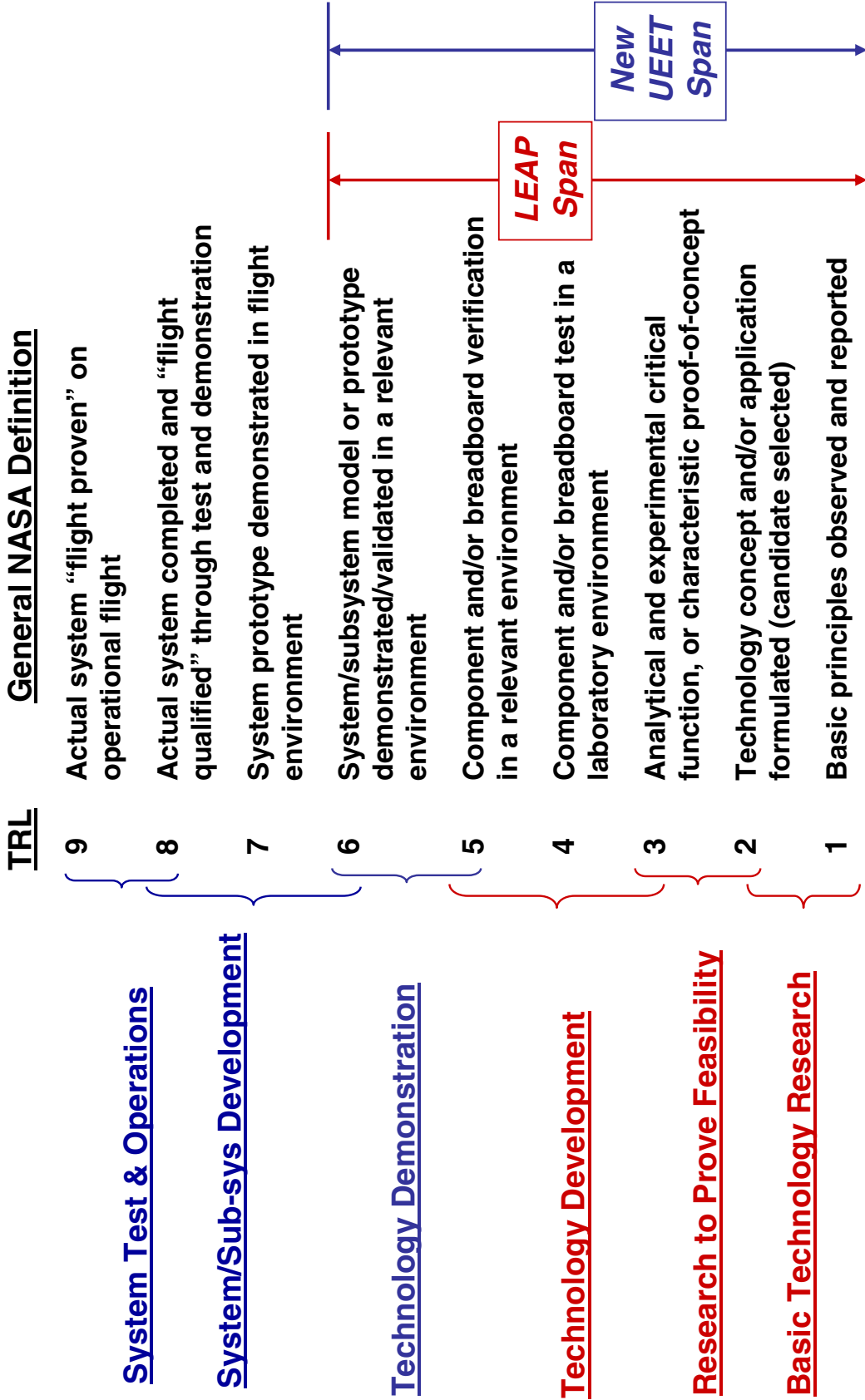


Vehicle Systems Program Structure (FY04+)

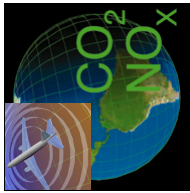


New Level II Projects

NASA's Technology Readiness Level (TRL) Scale

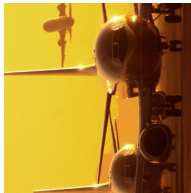


Theme Objectives Addressed by Vehicle Systems



Protect the Environment

Protect local and global environmental quality by reducing aircraft noise and emissions.



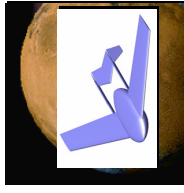
Increase Mobility

Enable more people and goods to travel faster and farther, anywhere, anytime with fewer delays



Protect the Nation







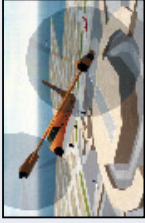



Enhance the nation's security through aeronautical partnerships with DOD and other government agencies.



Explore Revolutionary Aeronautical Concepts

Pioneer novel aeronautical concepts to support earth and space science missions and new commercial markets.

Twelve Notional Vehicles of the Vehicle Systems Program

 <p>Minimum environmental impact, maximum efficiency</p> <p><i>ST: Clean Transport</i></p>	 <p>Strengthen national security through rapid deployment and global reach</p> <p><i>SSA: Global Strike</i></p>	 <p>Conduct extended science and exploration missions</p> <p><i>UAV: Planetary Flight Vehicles</i></p>
 <p>All hour access to any location without noise disturbance</p> <p><i>ST: Santa Monica at Midnight</i></p>	 <p>Global reach and on-demand delivery</p> <p><i>ST: Global Reach Transport</i></p>	 <p>Rural, regional, and intra-urban transportation</p> <p><i>PAV: Personal Air Vehicle</i></p>
 <p>Rural and regional economic growth, time critical transport</p> <p><i>ST: Heartland Express</i></p>	 <p>Automated refueling capability, ultra-long endurance, wide speed range</p> <p><i>ST: Tanker</i></p>	 <p>Enables city center access in all weather</p> <p><i>RIA: V/STOL Commuter</i></p>
 <p>Expands the use of existing airport infrastructure</p> <p><i>RIA: Extreme STOL Transport</i></p>	 <p>Reduce passenger flight time by at least a factor of 2</p> <p><i>SSA: Supersonic Overland</i></p>	 <p>High altitude observations for science, and defense</p> <p><i>UAV: High Altitude Long Endurance</i></p>

ST: Subsonic Transport, SSA: Supersonic Aircraft, PAV: Personal Air Vehicle, UAV: Uninhabited Air Vehicle, RIA: Runway Independent Aircraft

Vehicle Systems

Work Breakdown Structure

New Aircraft Energy Sources and Management

<Strategic Focus>

Focus: Discover new energy sources and intelligent management techniques directed towards zero emissions and enable new vehicle concepts for public mobility and new science missions

• **Low Emissions Alternative Power - LEAP (GRC)**

- GRC - Constant Volume Combustion Cycle Engine
- GRC – Aircraft Fuel Cell Power System
- GRC - Alternative Fuel Foundation Technologies
- GRC - Propulsion URETI
- HQ - Advanced Aircraft

<Project>

<Subprojects>

Environmentally Friendly, Clean Burning Engines

<Strategic Focus>

Focus: Develop innovative technologies to enable intelligent turbine engines that significantly reduce harmful emissions while maintaining high performance and increasing reliability

• **Ultra Efficient Engine Technology - UEET (GRC)**

- GRC - 70% NOx Reduction Combustor (GRC)
- GRC - Highly Loaded, Light Weight Compressor and Turbine
- LaRC - Highly Integrated Inlet
- GRC - UEET Integration and Demonstration
- GRC - Intelligent Propulsion System Foundation Technologies

<Project>

<Subprojects>

& Noise Reduction

Vehicle Systems Strategic Focus - Supporting Projects

New Aircraft Energy Sources and Management

Discover new energy sources and intelligent energy management techniques directed towards zero emissions and enable new vehicle concepts for public mobility and new science missions.

New Aircraft Energy Sources and Management

FY04 FY05 FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14

Regen Fuel Cell (FSD)

Flight demonstration of multiple day, unrefueled flight using a hydrogen/air fuel cell power system.

Low Emissions Alternative Power

Demonstrate through integrated ground tests, a constant volume combustor in an engine system, and a UAV/small transport aircraft fuel cell-based power generation system.

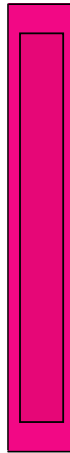
LEAP Demo (FSD)

Flight demonstration of a UAV fuel cell-based power system providing extremely long duration flights.

Alternative Energy Systems

Perform a ground demonstration of an integrated alternative-fueled engine-power system for a small transport aircraft.

FSD = Full Scale Demonstration



LEAP Subprojects



Low Emissions Alternative Power

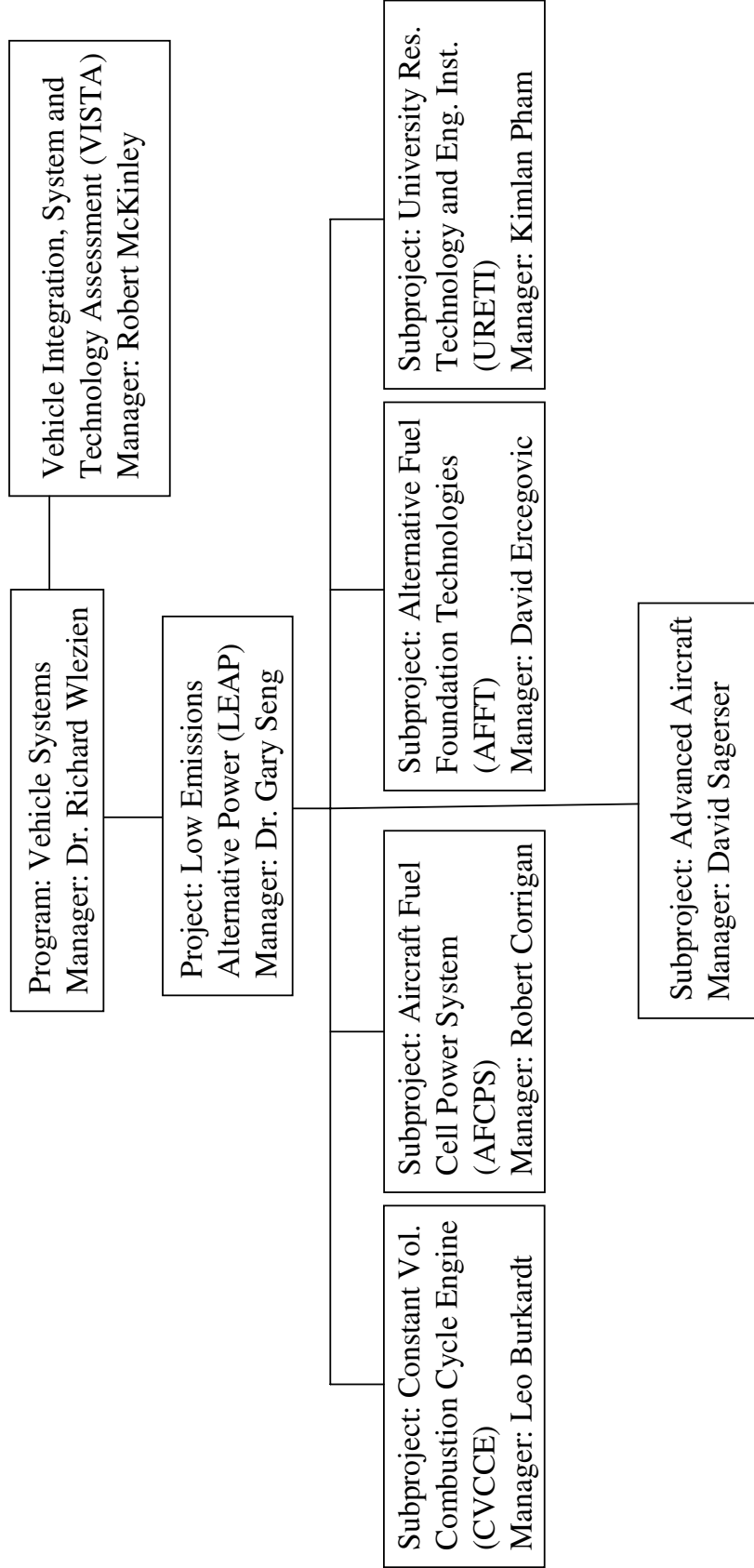
Constant Volume Combustion Cycle Engine (CVCCCE) - Develop hybrid constant volume combustion engine subsystem and system technology, and demonstrate feasibility through system analysis and ground demonstration testing.

Aircraft Fuel Cell Power System (AFCPS) - Develop and demonstrate a prototype fuel cell based power generation system for UAV/small transport aircraft in an integrated ground test.

Alternative Fuel Foundation Technologies (AFFT) - Discover new energy sources, unconventional propulsion systems and engines, and new power systems that have the potential to greatly reduce emissions, enable new vehicle concepts for public mobility, enhance national security or develop new scientific concepts (technology concept horizon 20-40 years).

University Research Engineering, Technology Institute (URETI) - Develop revolutionary aeropropulsion and power technologies and design methods in a systems-oriented integration environment.

LEAP Project Structure



Aeropropulsion Vision

Advanced propulsion and power technologies and new concepts to enable Aeropropulsion Revolutions.

