

OVERVIEW OF NASA'S UEET PROGRAM

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**NASA's Ultra Efficient Engine Technology  
(UEET) Program**

**Contributing to  
U. S. Aeropropulsion Technology  
Leadership  
in the 21st Century**

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Cleveland, OH



# Program Overview



Ultra Efficient Engine Technology

***Vision:***        *Develop and hand off revolutionary turbine engine propulsion technologies that will enable future generation vehicles over a wide range of flight speeds.*

***Goals:***

*Propulsion technologies to enable increases in system efficiency and, therefore, fuel burn reductions of up to 15 % (equivalent reductions in CO<sub>2</sub>)*

*Combustor technologies (configuration and materials) which will enable reductions in LTO\* NO<sub>x</sub> of 70% relative to 1996 ICAO standards.*

\* LTO - Landing/Take-off



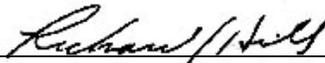
# Vision



Ultra Efficient Engine Technology

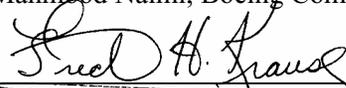
*Develop and hand off revolutionary propulsion turbine engine technologies that will enable future generation vehicles over a wide range of flight speeds.*

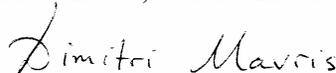
**We support the vision and are committed to the success of NASA's Ultra Efficient Engine Technology (UEET) Program.**

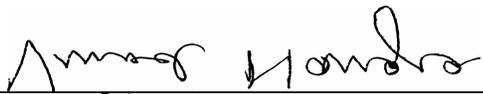
  
Richard Hill, Air Force Research Laboratory

  
Gerald Brines, Allison-Rolls Royce

  
Mahmood Naimi, Boeing Commercial Airplane Company

  
Fred Krause, General Electric Aircraft Engines

  
Dimitri Mavris, Georgia Tech

  
Vinod Nangia, Honeywell

  
Jeffrey W. Hamstra, Lockheed-Martin

  
Robert J. Shaw, NASA Glenn Research Center

  
Robert D. Southwick, Pratt & Whitney

  
Scott Cruzen, Williams International



**Honeywell**

LOCKHEED MARTIN



Williams International

# Baseline Vehicles for UEETP Technology Application Studies



Ultra Efficient Engine Technology

Commercial Vehicles

## Subsonic

300 PAX

Large Subsonic Transport



50 PAX

Regional Jet Transport



500-600 PAX

Blended Wing Body (BWB)



## Supersonic

300 PAX

High Speed Civil Transport (HSCT)



10 PAX

Supersonic Business Jet (SBJ)



## Hypersonic

These vehicles drive the technology investment strategy

Non-Commercial Vehicles

4 PAX



General Aviation Aircraft (GA)



Military Transport (C-17)



Unmanned Aerial Vehicle (UAV)

Advanced Fighter



Access-to-Space/High Mach Platform



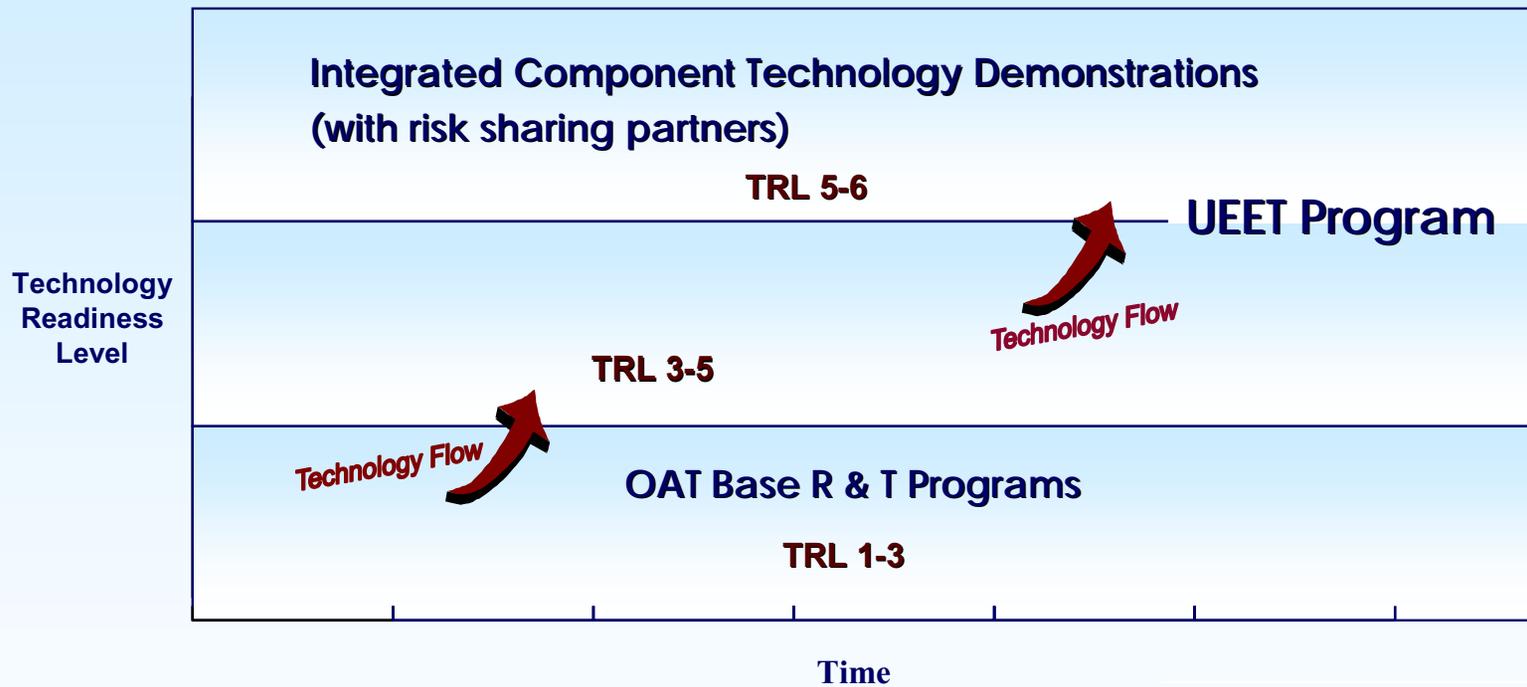
These vehicles determine the technology synergies



# Program Hierarchy



Ultra Efficient Engine Technology

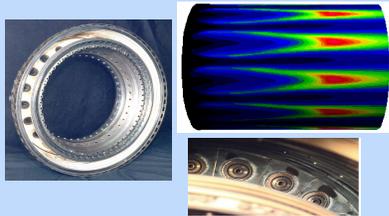


# UEET Projects



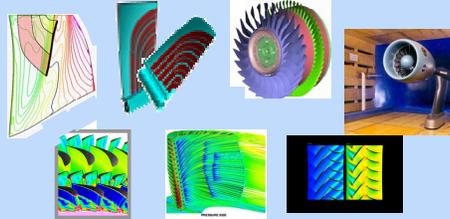
Ultra Efficient Engine Technology

## Emissions Reduction



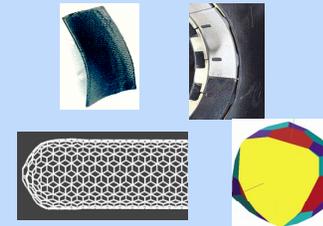
GRC Lead

## Highly Loaded Turbomachinery



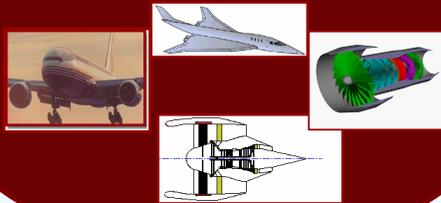
GRC Lead

## Materials and Structures for High Performance



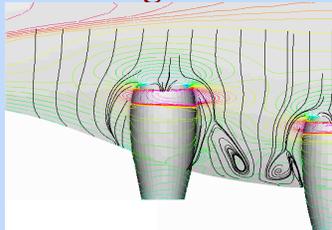
GRC Lead

## Propulsion Systems Integration and Assessment



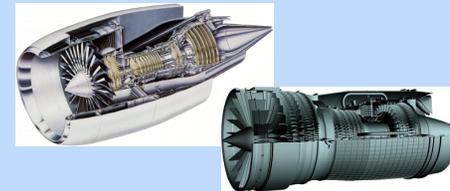
GRC Lead

## Propulsion-Airframe Integration



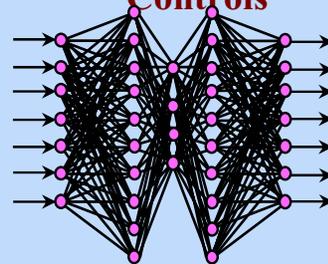
LaRC Lead

## Integrated Component Technology Demonstrations



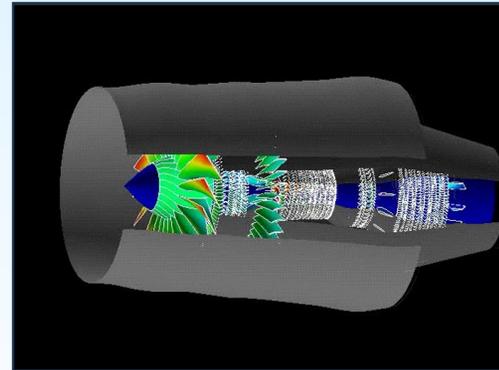
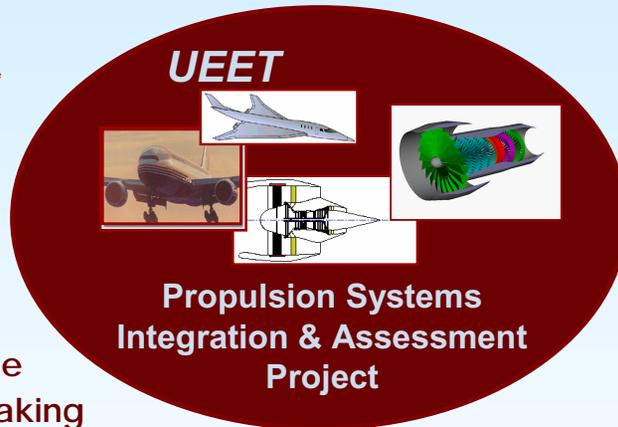
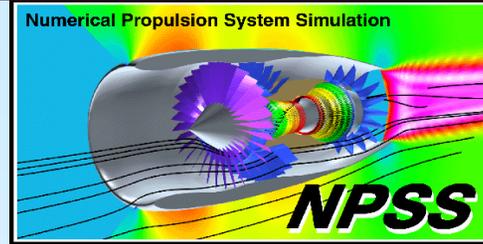
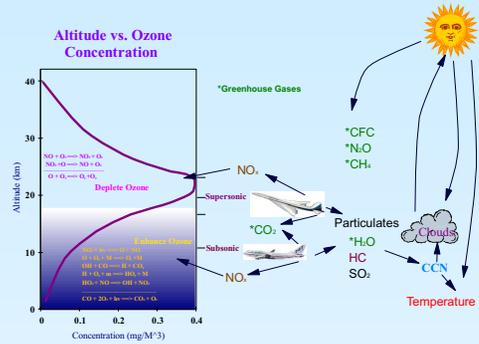
GRC Lead

## Intelligent Propulsion Controls



GRC Lead



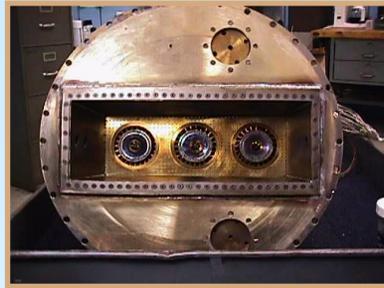


**P**rovide system level guidance for programmatic decision making

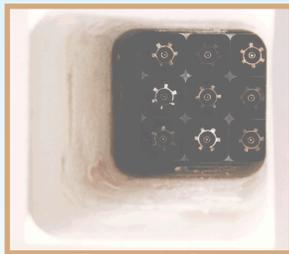
- System trade studies
- Technology assessments (metrics tracking and rollup)

**A**ssess the effects of engine exhaust products on the atmosphere and humans

**P**erform high fidelity system simulations to reduce experimental testing required and predict characteristics of future turbine engine propulsion systems

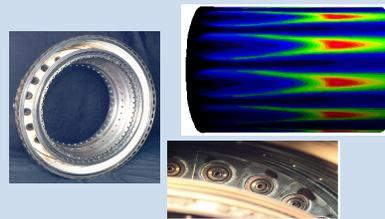


Annular rig

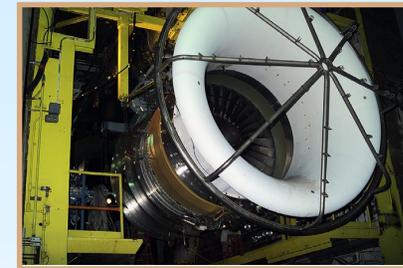


Flame tube

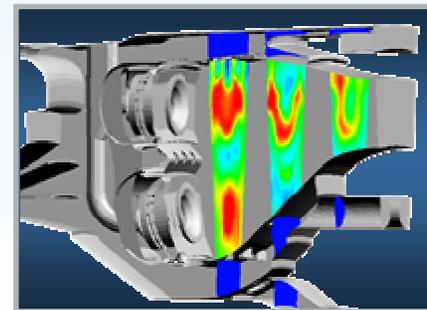
### UEET



Combustion Project

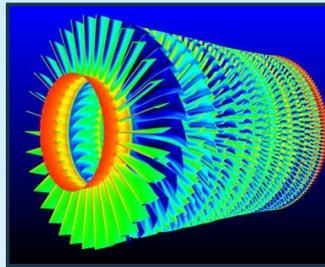


Engine validation  
(partnership with industry)

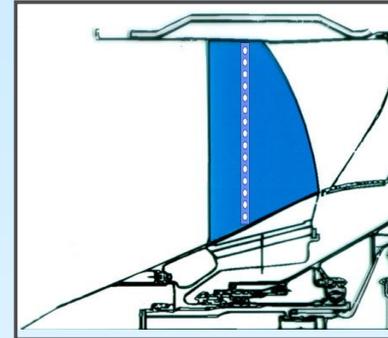


**Work with the U. S. industry to provide technology readiness to reduce combustion emissions of future aircraft:**

- 70% LTO  $\text{NO}_x$  reduction for large and regional subsonic engines
- Ultra low levels of cruise  $\text{NO}_x$  for supersonic aircraft
- Validated combustor analysis and design codes

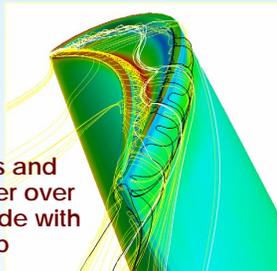


CFD Simulation of Multistage Axial Compressor using APNASA Code

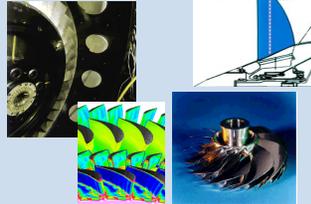


3D Coupled Internal/External Simulation of Film-Cooled Turbine Vane

Streamlines and heat transfer over turbine blade with recess in tip

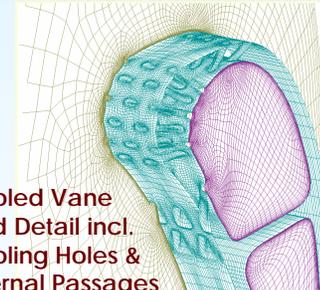


**UEET**

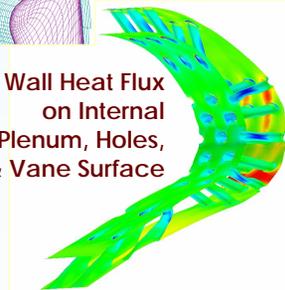


**Turbomachinery Project**

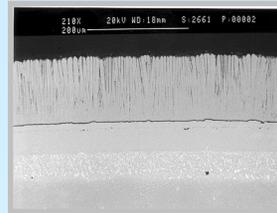
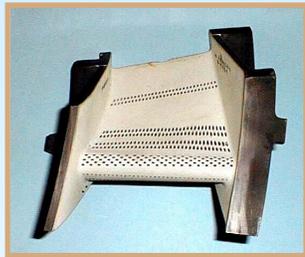
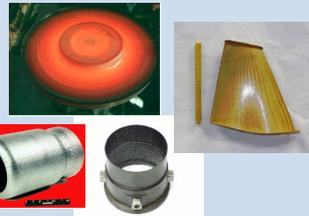
Cooled Vane Grid Detail incl. Cooling Holes & Internal Passages



Wall Heat Flux on Internal Plenum, Holes, & Vane Surface



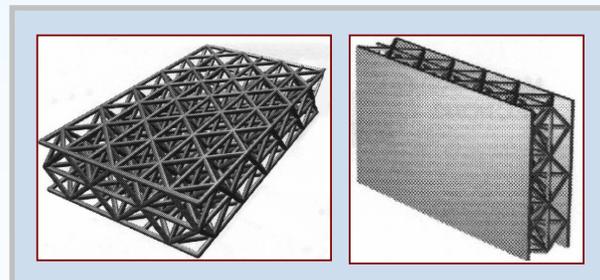
**Develop and demonstrate through component tests and analyses the turbomachinery technologies required for lightweight, reduced stage cores, low pressure spools, and propulsors for high-performance, high efficiency and environmentally compatible propulsion systems.**

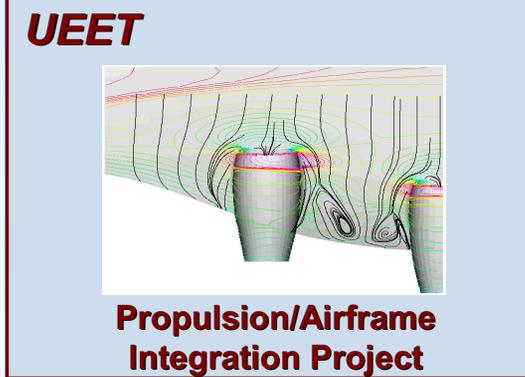
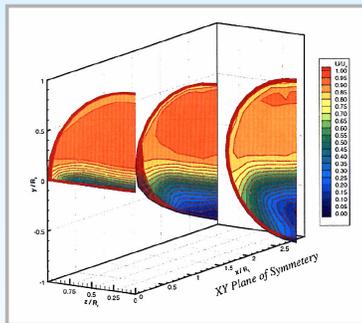
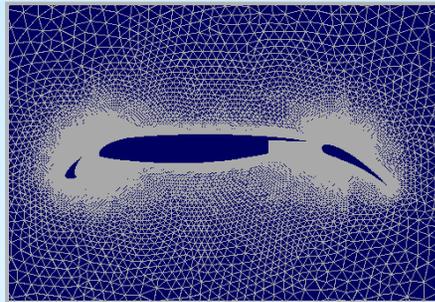
**UEET****Materials and Structures Project**

**Develop and demonstrate high temperature engine material systems which will enable future high performance, environmentally compatible turbine engine propulsion systems**

- Ceramic matrix composite (CMC) combustor liner
- CMC turbine vane
- Turbomachinery disk and turbine airfoil

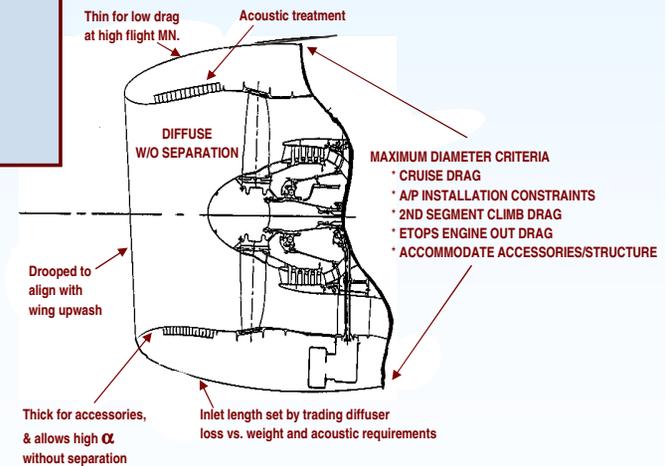
**Develop innovative low weight structural concepts**





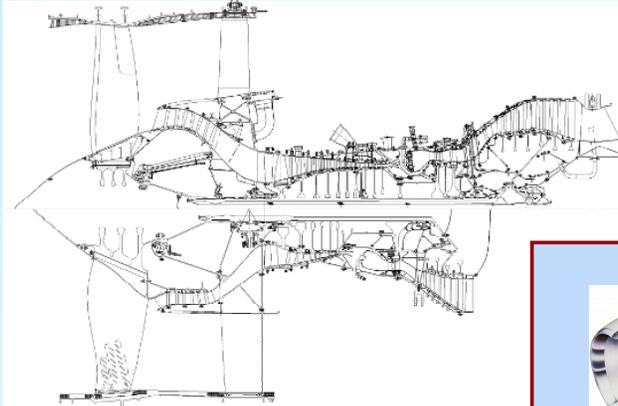
**Develop and demonstrate technologies which will enable low drag, high performance propulsion system integration for a wide range of vehicle classes**

- Validated, rapid turnaround design tools
- Active flow control
- Active shape control



# UEET

Ultra Efficient Engine Technology



## Integrated Component Technology Demonstrations Project

- NASA / DOD / U.S. industry a means to conduct technology demonstration tests of advanced turbine engine components and materials as part of an integrated system (TRL 6).
- Assessment of NASA and contractor technologies for demo program consideration.
- Significant technology risk reduction.
- Confidence in advanced technologies to facilitate incorporation in follow-on product insertion programs.



# The UEET "Roadmap"



Ultra Efficient Engine Technology

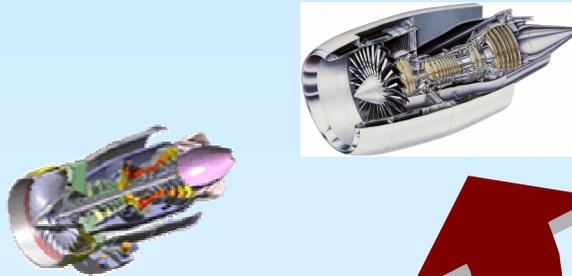
UEET Technologies  
• Components  
• Materials and structures  
• Intelligent propulsion controls

Periodic assessments/  
redirections

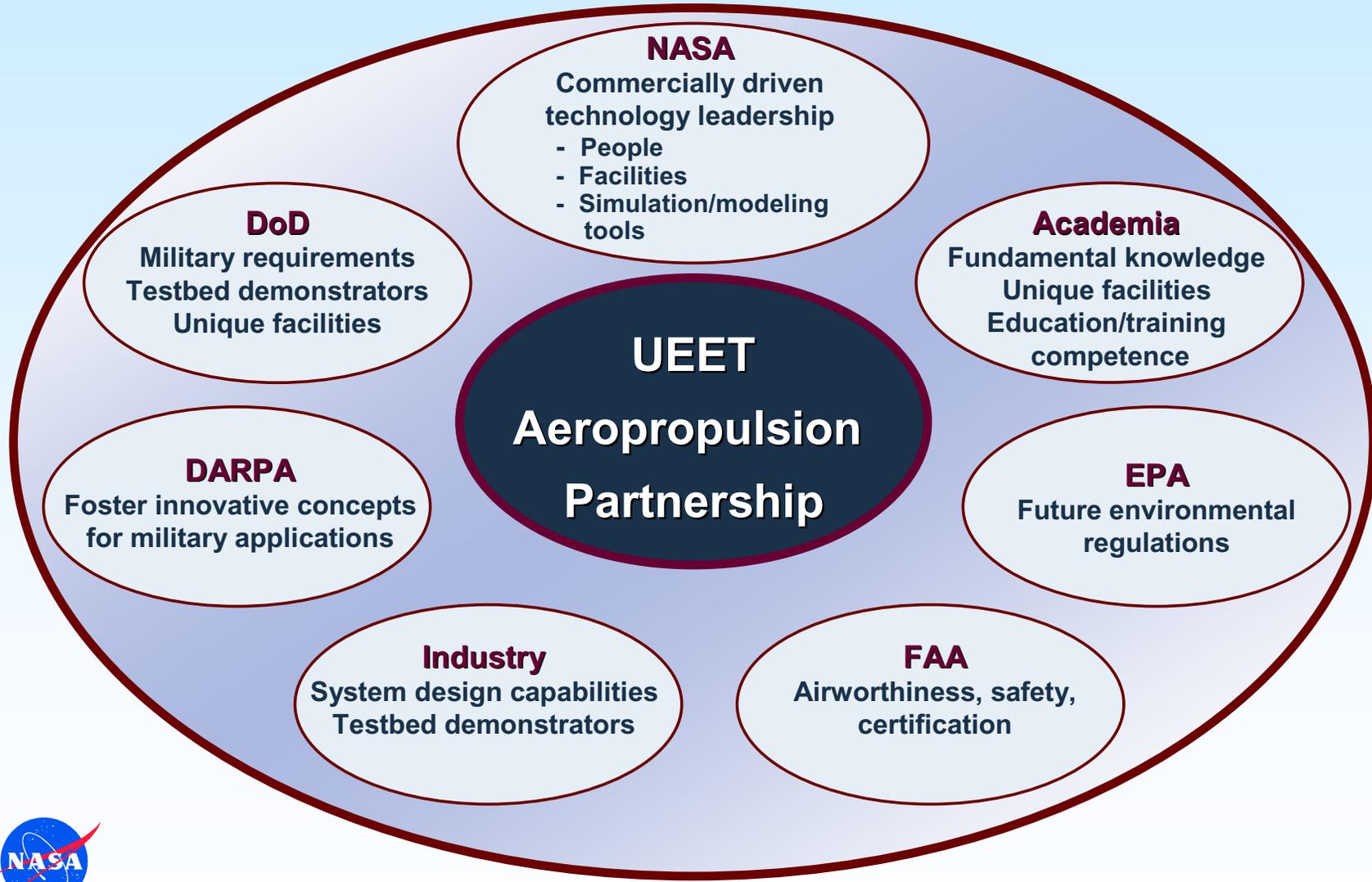
## "Ultimate" Turbine Engine Systems

- Fuel burn
- Weight
- Emissions
- Noise
- Safety
- Reliability

Integrated component  
technology validations  
(in partnership with other  
government agencies  
and/or industry)



# Each Partner Brings Unique Strengths to the National Partnership



## Concluding Remarks



Ultra Efficient Engine Technology

- The UEET Program will provide the revolutionary technologies needed to enable future turbine engine propulsion systems for a wide variety of aerospace vehicles.
- Systems requirements studies done with the U.S. Industry and Academia will provide key inputs to determining the long term direction for the program.
- The UEET Program content will be adjusted on a regular basis so as to pursue the highest payoff technology set.
- The UEET Program will partner wherever appropriate with NASA Base R&T Programs to transition technologies.
- The UEET Program will actively seek partners to carry the technologies to a TRL6 to enable timely transitions to future industry application specific designs.