Turbine Based Combined / Combination Cycle / RTA Project Overview

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Space Transportation Technology Workshop
Single Stage To Orbit (SSTO)
- Turbine Accelerator Integrated with Dual Mode Scram Jet in Combined Flow Path
- Over/under Configuration
- Hyper-X type vehicle (Baseline)

Two Stage To Orbit (TSTO)
- First Stage: Turbine Accelerator with Afterburner or Ram Jet
- Second Stage: RBCC and/or Rockets

Technology Challenges
- Turbine Accelerator
- Shared Inlet
- Dual Fuel (H/C & H2) in Single Vehicle
- Transition Mode
- Shared Mixer Ejector & Nozzle
- Thermal Management
- PAI

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Turbine Based Combined/Combination Cycle
Revolutionary Turbine Accelerator (RTA)

- Thrust/Weight ~20 (in-line)
- Mach 4-5 Capable
- Long Life

- **Current State-of-the-Art**
  - J58 Mach 3+ capable engine

- **Benefits of Technology**
  - Mach 4-5 turbine accelerator
  - Simplifies ramjet/scramjet geometry (decreases weight)
  - Improves system capacity & operability
  - Improves safety, survivability, abort capability & launch flexibility
  - Increases reliability & durability

- **Technical Challenges**
  - High Mach compressor
  - Thermal management
  - Hot rotating components
  - Advanced materials
  - Propulsion/Airframe Integration

- **Participants**
  - GRC (lead), LaRC, MSFC
  - AF, NAVAIR

Turbine Based Combined Combination Cycle
Revolutionary Turbine Accelerator (RTA) Technologies

Dual Mode Scram Jet Technologies (Hyper-X)

Turbine Based Combined/Combination Cycle
SSTO (TBCC/RTA)

- SSTO
  - Turbine Accelerator Integrated with Dual Mode Scram Jet in Combined Flow Path
  - Over/under Configuration
  - Hyper-X type vehicle (Baseline)

Turbine Based Combined Cycle
TSTO (TBCC/RTA)

Vehicle System

First Stage:
Turbine Accelerator with Afterburner or Ram Jet

Second Stage:
AB RBCC and/or Rockets

Turbine Based Combined/Combustion Cycle
TBCC/RTA Technical Challenges

Inlet Design:
- Location (ahead, inside SJ inlet)
- Mode Transition
- Boundary layer control
- Performance
- Highly offset, subsonic diffuser
- Quality of flow
- Unstart susceptibility
- Separate inlets vs. single aperture
- Variable geometry (in or out doors)
- Weight/complexity

Turbine Accelerator:
- Protection from high temperatures for all configurations
- In flight restart

Nozzle:
- Exit location
- Design and performance
- Size & weight
- Mode transition interaction

Additional Technical Challenges:
- Thermal management
- High temp seals
- Materials and Structures
- Integration
- Integrated flight controls
- Fuel system, cooling
- Vehicle design, CG
- Pitching moment

Ejector Region:
- Mixing performance and its impact on overall system performance
- Mixing enhancement
- Mode transition
- Thermal choke performance and locations control

Turbine Based Combined/Combination Cycle