UEET Integrated Inlet Propulsion System Study (IIPSS) Program

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Program Overview

• Determine optimum supersonic business jet (SSBJ) airframe/propulsion system that minimizes sonic boom and maximizes aircraft performance for Mach 1.6-2.0 overland flight conditions

• Meet Stage 4 noise requirements

• Assess impact of possible future regulatory emissions requirements

• AADC/Rolls-Royce provide propulsion system support (engine and exhaust)

• Lockheed Martin and Gulfstream provide propulsion/airframe integration studies including the inlet
• Study two vehicle integrated propulsion systems:
  - High Bypass Ratio (HBR) engine
  - Highly Variable Cycle (HVC) engine

• Include inlet and nozzle in studies that minimize sonic boom for each propulsion system.

• Technology availability date (TAD) of 2010

• Entry into service (EIS) of 2015
NASA Glenn Research Center (GRC) in consultation with AADC/Rolls-Royce and the airframers will downselect the integrated propulsion system concept

• AADC/Rolls-Royce will consult with GRC and airframers in downselection of propulsion system components and technologies

• AADC/Rolls-Royce will determine the Technology Readiness Level (TRL) of all critical and/or enabling propulsion technologies

• AADC/Rolls-Royce will develop Technology Roadmaps for all critical and/or enabling propulsion technologies
Fixed Cycle Engine

Relative to highly variable cycle engine:

Advantages:

• Simpler mechanically
• Lower maintenance
• Conventional turbomachinery (reliable)

Disadvantages:

• Less flexible air flow schedule across flight regime
• Engines typically sized to meet take-off noise requirement
Variable Cycle Engine

Relative to a high bypass ratio fixed cycle engine:

Advantages:

• More flexible airflow scheduling across flight regime
• Potential to better match aircraft thrust requirements at take-off, transonic and cruise points

Disadvantages:

• Multiple variable geometry devices (inlet, engine, nozzle)
• Numerous aero/mechanical design challenges
• Possible higher maintenance
• Unproven field experience (reliability questions)
Exhaust System Considerations

- Stage 4 noise requirements
- Aircraft thrust requirements (high Cfg)
- High temperature environment
The Concorde Variable Area, Con-di, Thrust Reversing Nozzle
• Rolls-Royce has 27 years experience in Mach 2 commercial flight (Concorde/Olympus)

• Rolls-Royce has studied SSBJ propulsion requirements for over a decade with airframe companies worldwide

• AADC has more than a decade experience in High Mach propulsion demonstrators

• AADC has more than two decades experience in high temperature technologies
Rolls-Royce Olympus 593 Operational Data:

- Total engine flying hours = 928,000
- Total engine flying hours above M1.0 = 595,000
- Total engine flying hours above M2.0 = 473,000
• Quiet Supersonic Platform (QSP)

• Ultra-Efficient Engine Technology (UEET):
  - Regional jets
  - Access to space

• Long Range Strike (LRS, Mach 2-4)

• JETEC (Mach 3.5 demonstrator engine)

• IHPTET (Technology demonstrators)

• VAATE (Performance/Cost Capabilities)
Fly Fast: Mach 2.4  (Concorde: Mach 2.0)
Fly Quiet: Overland (Concorde: restricted to overwater)
Fly Far: 6000 miles  (Concorde: ~3000 miles)
## QSP Performance Goals

<table>
<thead>
<tr>
<th></th>
<th>QSP</th>
<th>Concorde</th>
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<tbody>
<tr>
<td><strong>Aircraft TOGW</strong></td>
<td>100,000 lbf</td>
<td>400,000 lbf</td>
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<tr>
<td><strong>Cruise Mach Number</strong></td>
<td>2.4</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>6,000 nm</td>
<td>3,150 nm</td>
</tr>
<tr>
<td><strong>Sonic Boom Ground Signature</strong></td>
<td>0.3 lb/sq ft</td>
<td>~2.5 lb/sq.ft.</td>
</tr>
<tr>
<td><strong>Lift to Drag Ratio</strong></td>
<td>11</td>
<td>7.4</td>
</tr>
<tr>
<td><strong>Payload Mass Fraction</strong></td>
<td>20%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Thrust SFC (dry)</strong></td>
<td>1.05 lb/lb-hr</td>
<td>1.19 lb/lb-hr</td>
</tr>
<tr>
<td></td>
<td>0.95 (M = 2)</td>
<td></td>
</tr>
<tr>
<td><strong>Engine Thrust to Weight Ratio</strong></td>
<td>7.5</td>
<td>4.0 (with A/B)</td>
</tr>
<tr>
<td><strong>Aircraft Weight Breakdown</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Payload</td>
<td>20%</td>
<td>6%</td>
</tr>
<tr>
<td>Empty</td>
<td>40%</td>
<td>44%</td>
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• Technologies identified in IIPSS program applicable to SSBJ, commercial transports and military applications for Mach 2 flight

• Possible markets include package and freight distribution, in addition to passenger travel

• Sonic boom mitigation is the enabling technology to make commercial supersonic flight economically feasible (permits both overland and overwater operations)

• AADC combines its high temperature technology with Rolls-Royce’s Concorde experience and lead position in SSBJ propulsion studies for the next generation of commercial/military supersonic flight