

# **AoA Current Status: Executive Summary**



What?

 Multi-disciplinary, multi-center teams were established in May to assess priority and enduring needs for three traditional NASA skill/capability areas (combustion/emissions, icing, and acoustics)

Whv?

- AAVP is shifting focus to advance four key areas in subsonic air transport research which may result in reduced demand by NASA for the three traditional skill areas
- However, there is recognition of potential enduring needs in these areas for the greater aviation community

How?

- Internal and external stakeholders are being surveyed to quantify needs in the skill/capability areas
- A variety of future realities are being considered to assess the 'technology landscape' for the capabilities

When?

- Report to be presented at the January 2021 Strategic Portfolio Management Review
- NASA TM(s) to document findings in the March 2021 timeframe

**Expected Outcome** 

 Recommendations for investments in the legacy and newly identified capability areas based on assessments of internal and external stakeholder inputs and NASA's enduring needs.

AoA Sponsors: Jim Heidmann (AATT) and Mike Rogers (TTT)

# Four Key Subsonic Transport Technologies, "Fab 4"

Create new "S" curve for the next 50 years of subsonic transports



### **Electrified Aircraft Propulsion**

- Improved efficiency/emissions
- Mild hybrid systems promising for early 2030s

#### **Small Core Gas Turbine**

- Increased gas turbine efficiency
- Facilitates airframe integration conventional or EAP

**Electrified Aircraft Propulsion** 



Small Core Gas Turbine

### **Transonic Truss-Braced Wing**

- Increased aerodynamic and structural efficiency
- Propulsion system integration and high rate production

**Transonic Truss-Braced Wing** 

### **High Rate Composite Manufacturing**

- Critical to US competitiveness via reduced delivery time
- Reduced time/cost to market with increased performance



**High Rate Composites** 

Advance key technologies to TRL 6 by 2025-28 to create early 2030s market opportunities for US industry

# **Analysis of Alternatives for NASA Legacy Research Areas**



#### **Acoustics**

- Cross-cutting technology required to address system-level community noise concerns
- Future concepts must be evaluated against future noise standards (e.g., TTBW)

#### Combustion

- Identify small core engine challenges for reduced emissions and with alt fuels
- Assess growing focus on nvPM emissions

#### **Icing**

- Assess icing impacts for small core engines and new configurations (e.g., TTBW)
- Inform design choices and the development of FAA certification standards

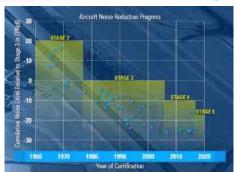
#### Four key objectives of the AoAs are:

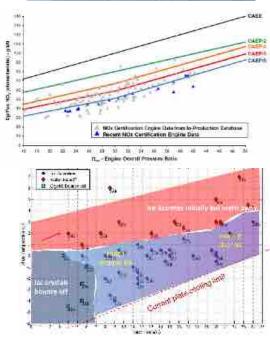
- An assessment of *priority needs* for each of the three legacy areas toward the four key 1. subsonic transport focus areas "Fab Four" and any other ARMD priority areas.
- 2. An assessment of *enduring needs* for the three legacy areas for the aviation community.
- An assessment of gaps in the NASA skills and capabilities after addressing these needs. 3.
- 4. Recommendations on how to reshape NASA capabilities to address the needs and gaps.

#### Team Leads and co-leads:

Acoustics - Dale Van Zante (& overall coordination), Cliff Brown, Doug Nark Combustion - Jennifer Klettlinger and Kathy Tacina Icing - Peter Struk, Andy Broeren, Mark Potapczuk

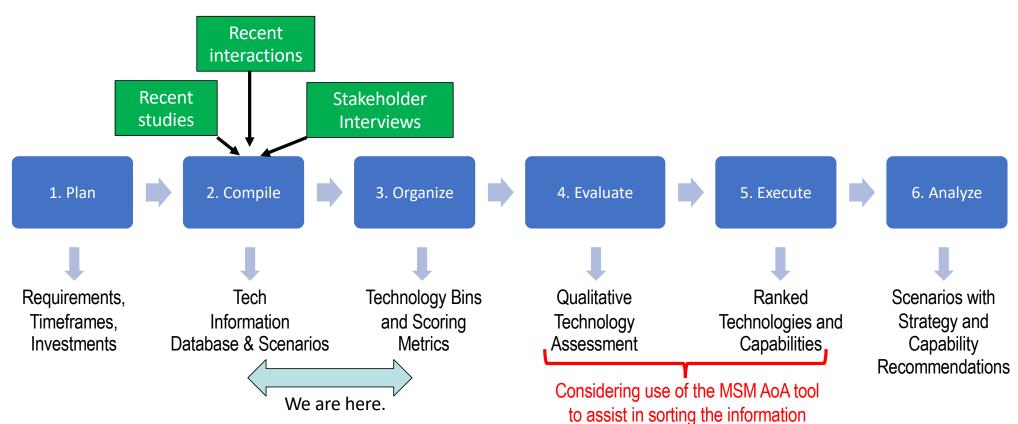
Multi-Center teams formed and report-outs planned for January 2021 to ARMD.





### **Overall AoA Process**



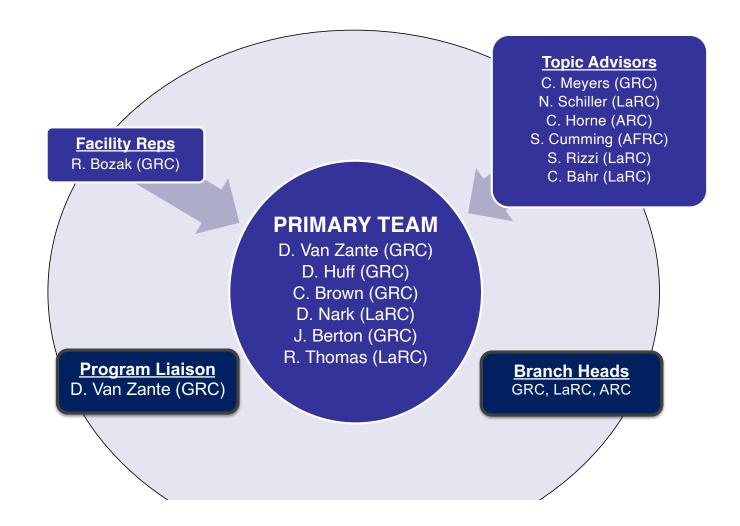


Modified from: MSM AoA DPMC Briefing Final Madavan.pdf

## **Acoustics Team**







### **Acoustics Internal and External Stakeholders**



Topic Advisors bring in the cross-program/project viewpoints for internal stakeholders. NASA Subsonic Metrics Goals, NASA Technology roadmaps, and GaTech Dashboard inform the scenarios.

#### Industry

Aircraft

Boeing

**Lockheed Martin** 

Northrop

**Engine** 

General Electric Pratt & Whitney + RTRC Honeywell

Suppliers/Support **Collins Aerospace** Hexcel

#### Regulatory

FAA

Office of Environment and Energy **CLEEN Program** 

NASA SME involvement in ICAO Working Groups and Independent Expert Reviews.

#### DoD

Office of Naval Research Air Force Research Lab Army Research Lab **NAVAIR** 

#### **Other Sources:**

Acoustics Technical Working Group (TWG), Est. 1992: OEMs, academia, OGAs, airports and airlines

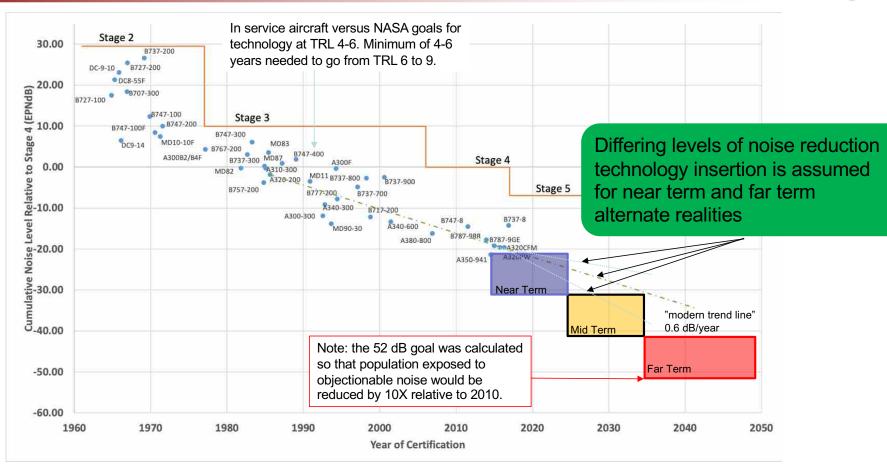
AeroAcoustics Research Consortium (AARC), Est. 2000: OEMs and academia

#### **Emerging Markets: Supersonics and RVLT/UAM**

ICAO involvement for supersonics **UAM Noise Working Group (UNWG)** 

# Range of NASA goals





## **Acoustics: Alternative Realities**



The Acoustics AoA team considered several future realities and defined their characteristics.

- The dominant characteristics of each reality will determine the aircraft systems that thrive.
- The a/c systems within each reality will have relevant/known acoustics tech/tools/processes associated with them
- Capabilities can then be mapped to the tech/tools/processes





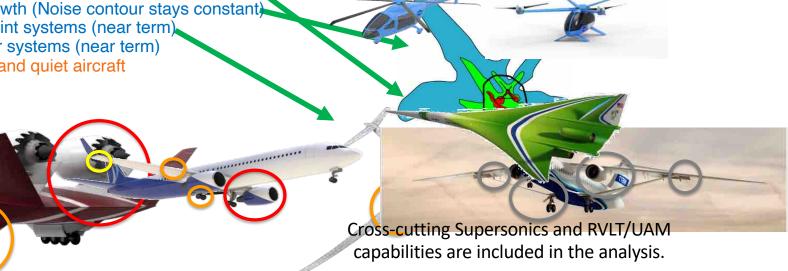
2. Near term return to growth (Industry noise reduction rate)

3. Near term return to growth (Noise contour stays constant)

4. Reduced carbon footprint systems (near term)

5. Reduced noise contour systems (near term)

6. Far term ultra efficient and quiet aircraft



Images: NASA

## **Focus of the Alternative Realities**



Scenarios differentiated by tech insertion rate to meet nominal noise targets

Edges of the design space scenarios

Scenario 6:

Scenario 6:

Scenario 6:

Long term ultra-quiet

Scenario 4: Low carbon

Scenario 5: Low noise

Different 'baskets' of technologies are associated with each scenario

# **AoA Analysis Overview**



## **Metrics**

### **Filters**

Technologies, Tools,
Facilities
Subsonic Fixed Wing Focus
SUP/RVLT/AAM cross-cutting techs

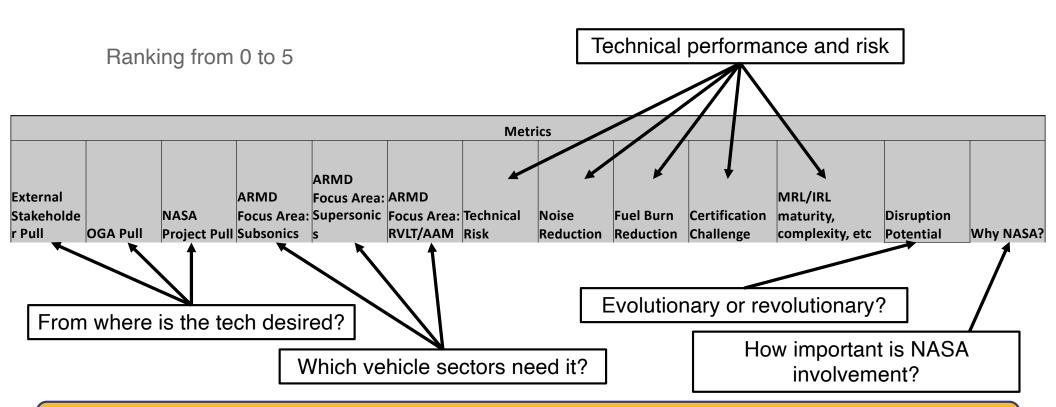
Each technology, tool and facility is ranked versus metrics (More details next)

Tech included in scenarios?
Tech included in Fab 4?
TRL level?
What facilities and tools are used?
Other factors...

Ranked listing of critical capabilities (skills/facilities/to ols) associated with the technologies.

### **Acoustics AoA Metrics**

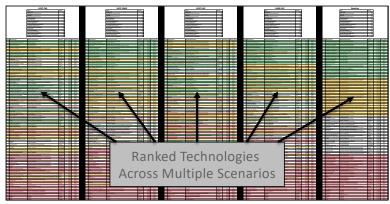




The technical performance and risk of a technology are only a portion of evaluating the criticality of a technology and its associated capabilities (skills/tools/facilities) to the acoustics discipline.

# **Analysis of the results**





**Interactive Multi-Scenario Evaluation Tool** 

- The Materials AoA developed an interactive Excel tool to evaluate multiple scenarios simultaneously
  - Visual display of rankings across several scenarios
  - Color coding of technologies across scenarios to help reveal trends

The Acoustics AoA team will translate 'technologies' to 'critical capabilities'.

This is an additional step that the Materials AoA did not do.

The Acoustics AoA analysis is in progress now.

# **Acoustics: Early Learnings**



### Some themes heard thus far from interviews:

 Benchmark aeroacoustic datasets have an enduring and widespread impact: comment from several stakeholders.

Examples: Fan Source Diagnostics Test (SDT) for fan performance/noise, Liner Technology Facility (LTF) acoustic liner impedance/drag tests, and the Benchmark problems for Airframe Noise Computations (BANC) for airframe sources.

 Acoustic technical expert consultation to FAA/ICAO and NASA acoustics models are crucial to U.S. leadership in the international regulatory environment.

This is an enduring NASA competency that supports U.S. industry competitiveness.

Working Groups provide a valuable and enduring venue for stakeholder interactions.

Urban Air Mobility Noise Working Group (UNWG)

Acoustics Technical Working Group (TWG)

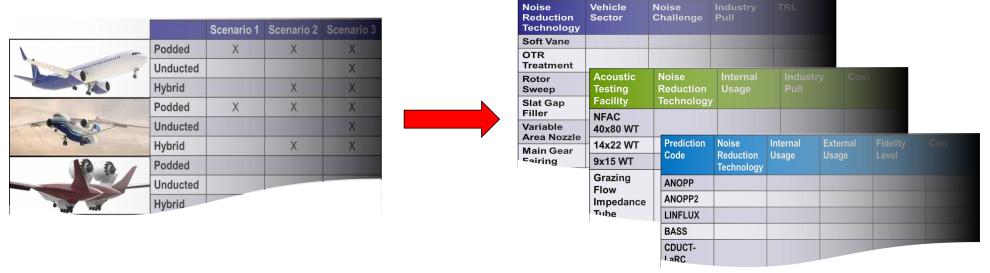
# **Acoustics: Expected Outcomes**



#### Acoustics AoA analysis assumptions:

- Subsonic and supersonic transports LTO noise is the primary focus (systems most impacted by pivot to Fab Four)
- RVLT acoustics research continues. AoA will only consider cross-cutting areas that may be impacted.
- UAM does not yet have well defined acoustics goals. AoA to analyze potential cross-cutting areas only.

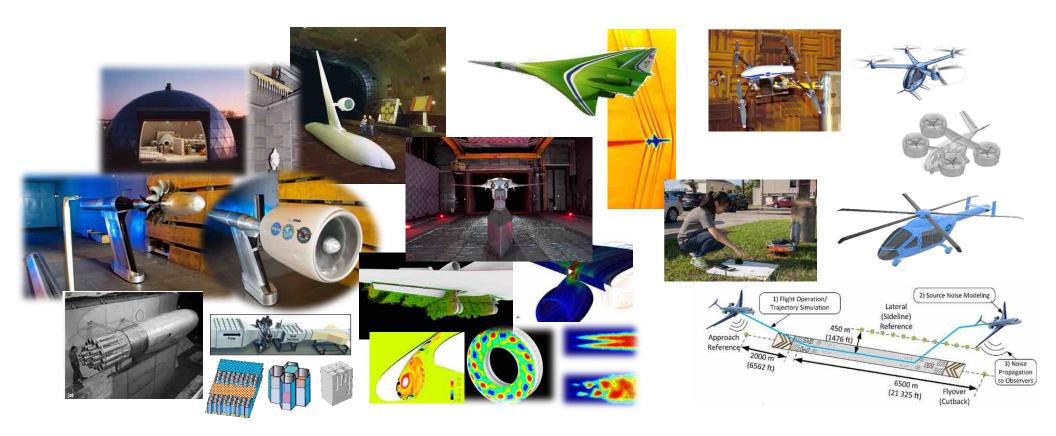
### **Expected Outcomes**



- Mapping technologies to capabilities and identify key, cross-cutting capabilities
  - Incorporates external/internal stakeholder input on subject matter expertise, facilities, and codes
  - · Scenarios used to classify technology applications across vehicles sectors and identify associated capabilities

# **Acoustics: History and discipline overview**





Questions for the Acoustics discipline?

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# TW160 Breakdown – Mid Term Technology Level

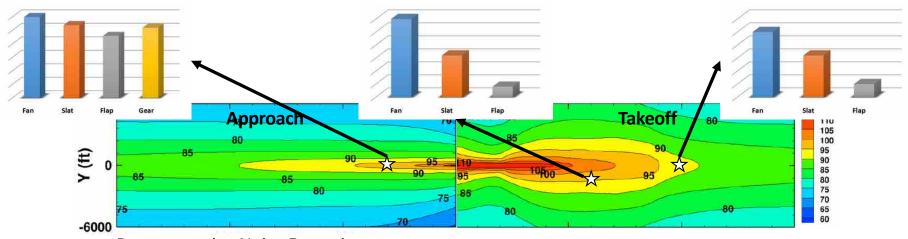




#### TW160 34.4 EPNdB

cumulative margin below Stage 4 predicted, Ref. AIAA-2019-2427

Includes MDOF, Soft Vane, Partial Main Gear Fairing and Flap Side Edge Treatment



Representative Noise Footprint

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Images: NASA