National Aeronautics and Space Administration

The Promise And Challenges Of Ultra High Bypass Ratio Engine Technology and Integration

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Ultra High Bypass Engine Technology Sub-Element
Propulsion Technology Element
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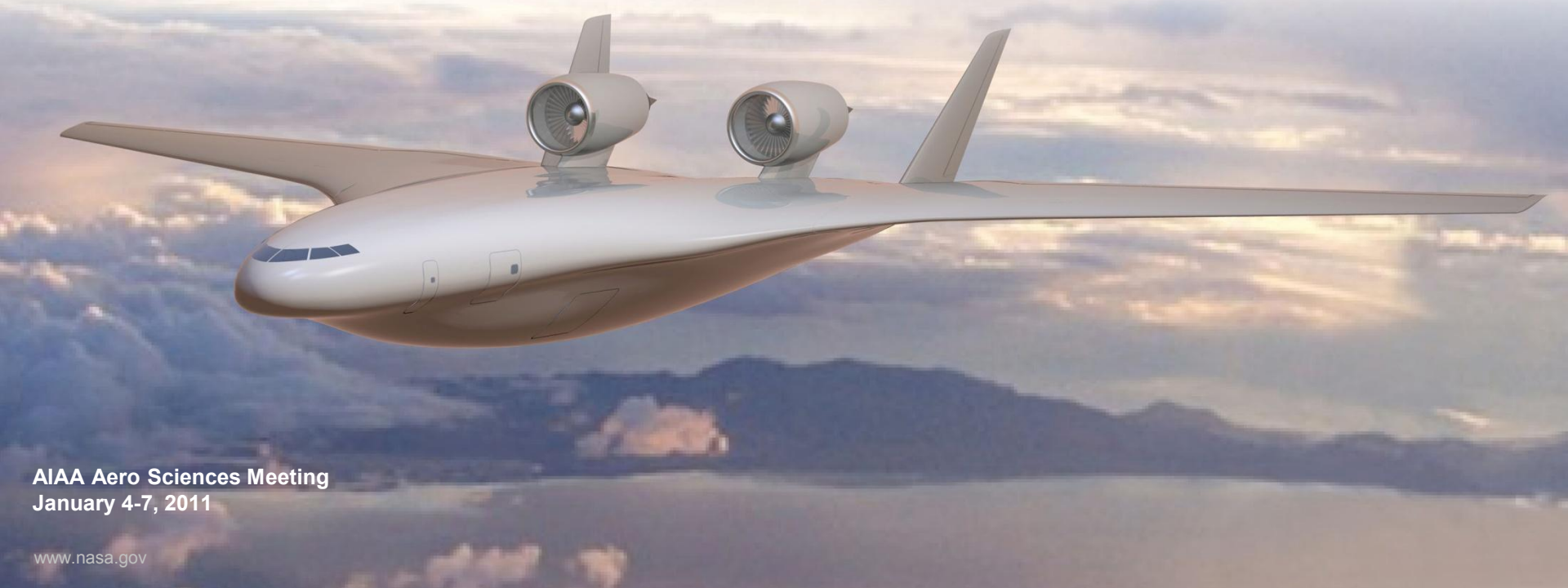
Environmentally Responsible Aviation Project
Integrated Systems Research Program



AIAA Aero Sciences Meeting
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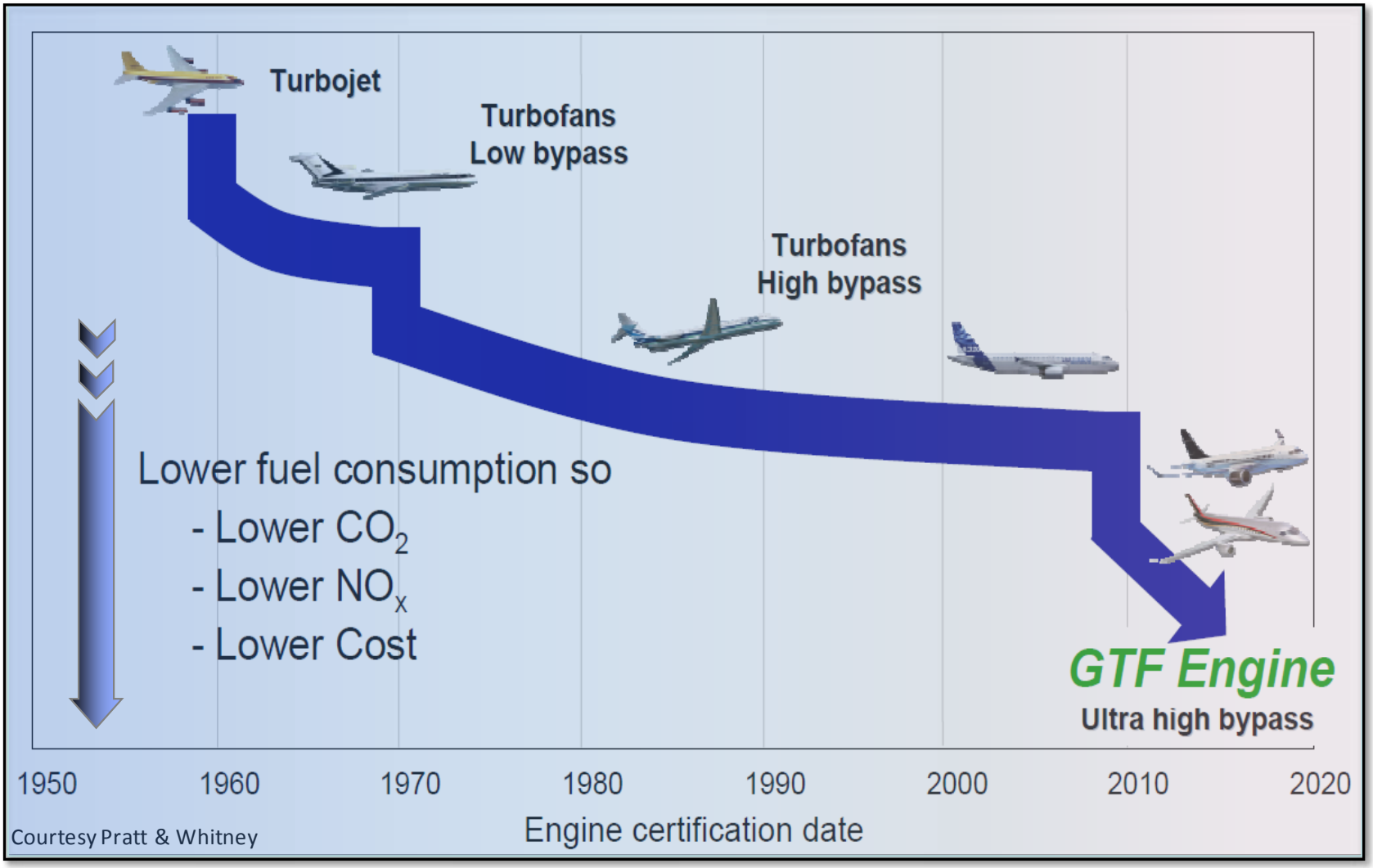
Geared Turbofan Technology Enables a Step-Change in Ultra High Bypass Propulsion



NASA's Subsonic Transport System Level Metrics

Summarizing the potential technology payoff …

…. Innovative technology for dramatically reducing noise, emissions and fuel burn

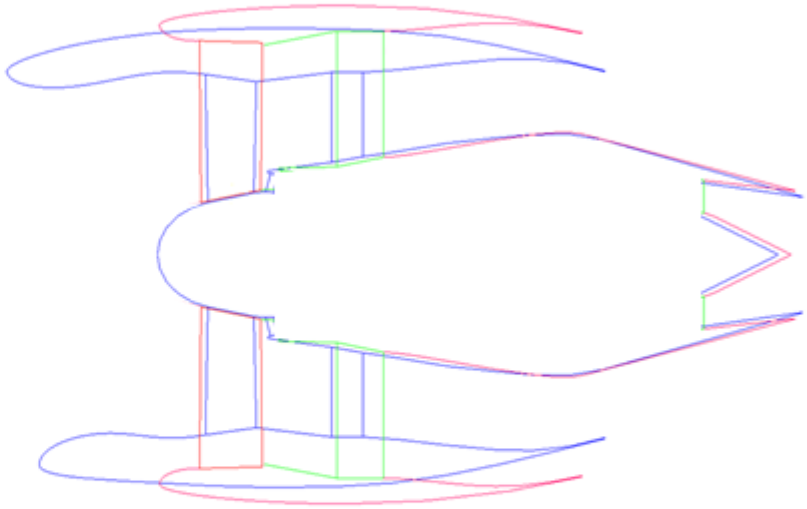
CORNERS OF THE TRADE SPACE	N+1 = 2015*** Technology Benefits Relative To a Single Aisle Reference Configuration	N+2 = 2020*** Technology Benefits Relative To a Large Twin Aisle Reference Configuration	N+3 = 2025*** Technology Benefits
Noise (cum below Stage 4)	-32 dB	-42 dB	-71 dB
LTO NO_x Emissions (below CAEP 6)	-60%	-75%	better than -75%
Performance: Aircraft Fuel Burn	-33%	-50%**	better than -70%
Performance: Field Length	-33%	-50%	exploit metro-plex* concepts

***Technology Readiness Level for key technologies = 4-6. ERA will undertake a time phased approach, TRL 6 by 2015 for "long-pole" technologies
** RECENTLY UPDATED. Additional gains may be possible through operational improvements
* Concepts that enable optimal use of runways at multiple airports within the metropolitan area

Propulsion System Fuel Burn Drivers

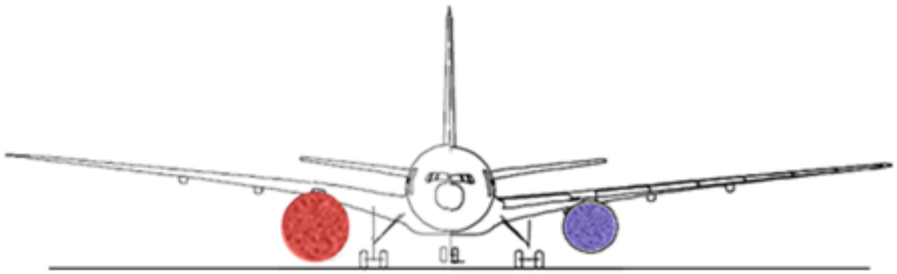
- ***Thrust Specific Fuel Consumption*** *– Need Higher Propulsive Efficiency, Which is Achieved with Higher Bypass Ratio, Lower Fan Pressure Ratio*

- ***Weight*** *– Need:*
  - *Advanced, Lighter Materials*
  - *Advanced, Smaller Core Components and More Compact Designs*

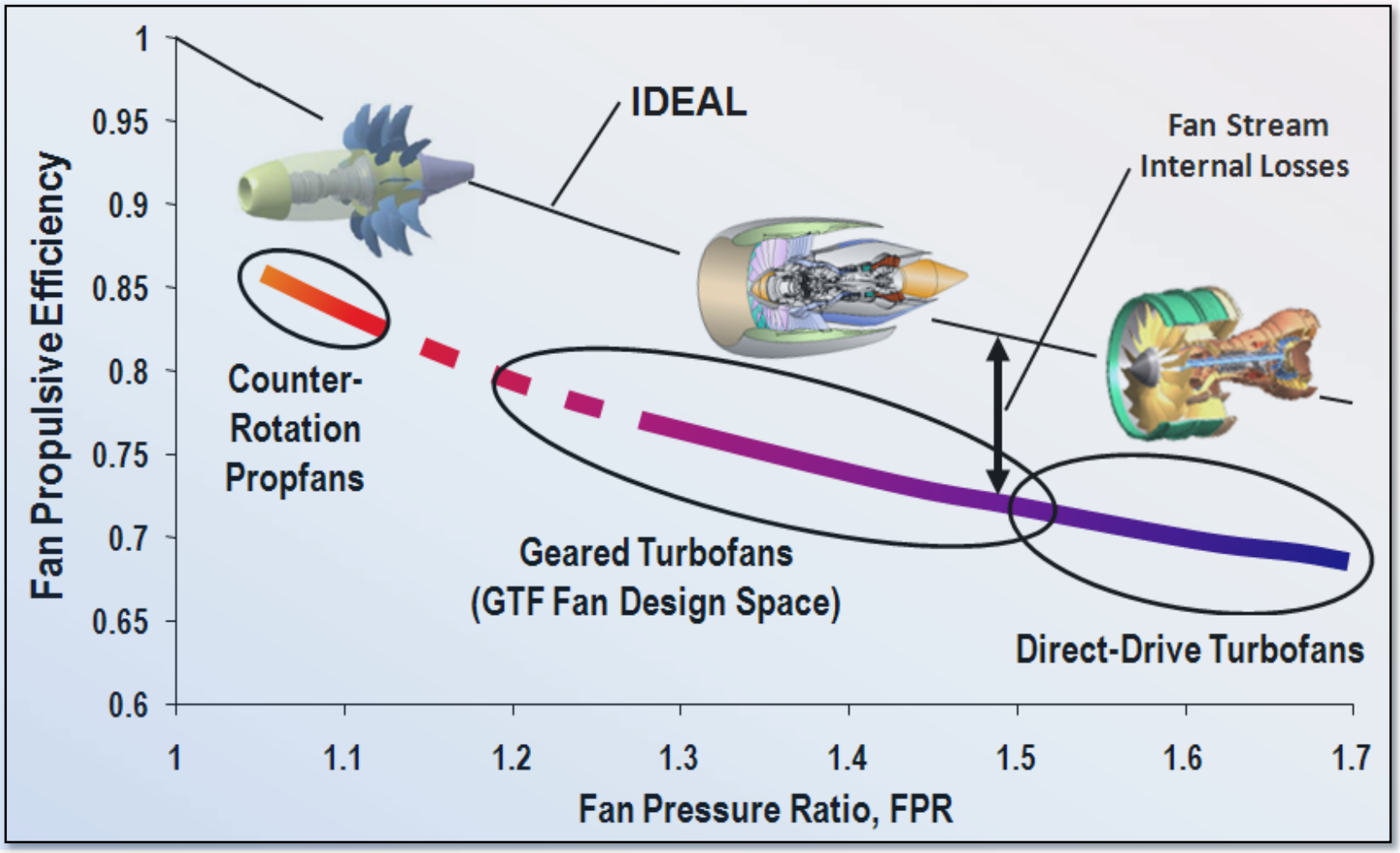


- ***Nacelle Drag*** *– Need Thinner, Shorter Nacelles as Engine Bypass Ratio and Fan Diameter Grow*

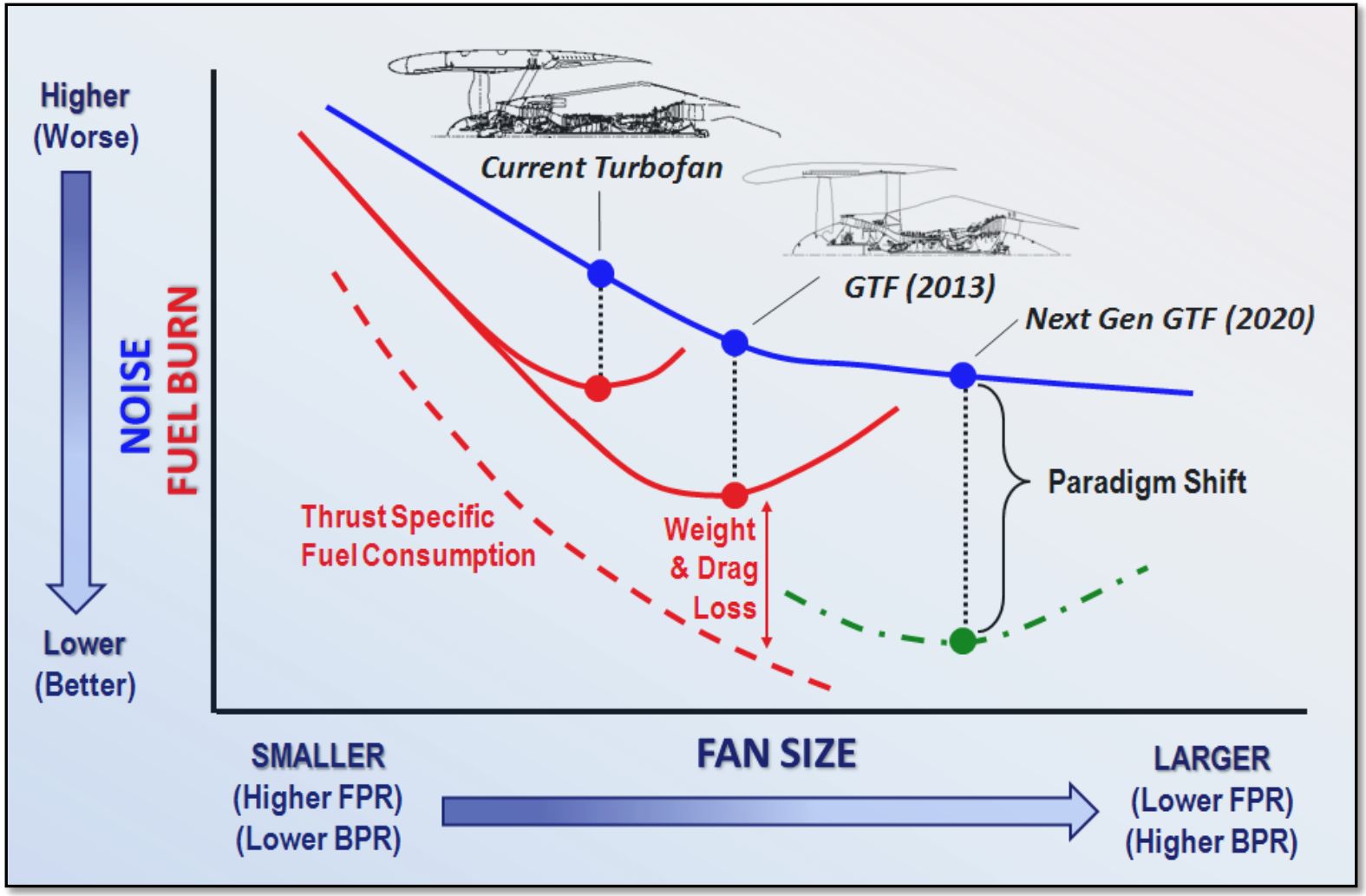
- ***Installation*** *– Need Special Designs to Integrate Bigger Engines and Minimize Impact on Aircraft Performance*



Propulsive Efficiency Trend with Fan Pressure Ratio

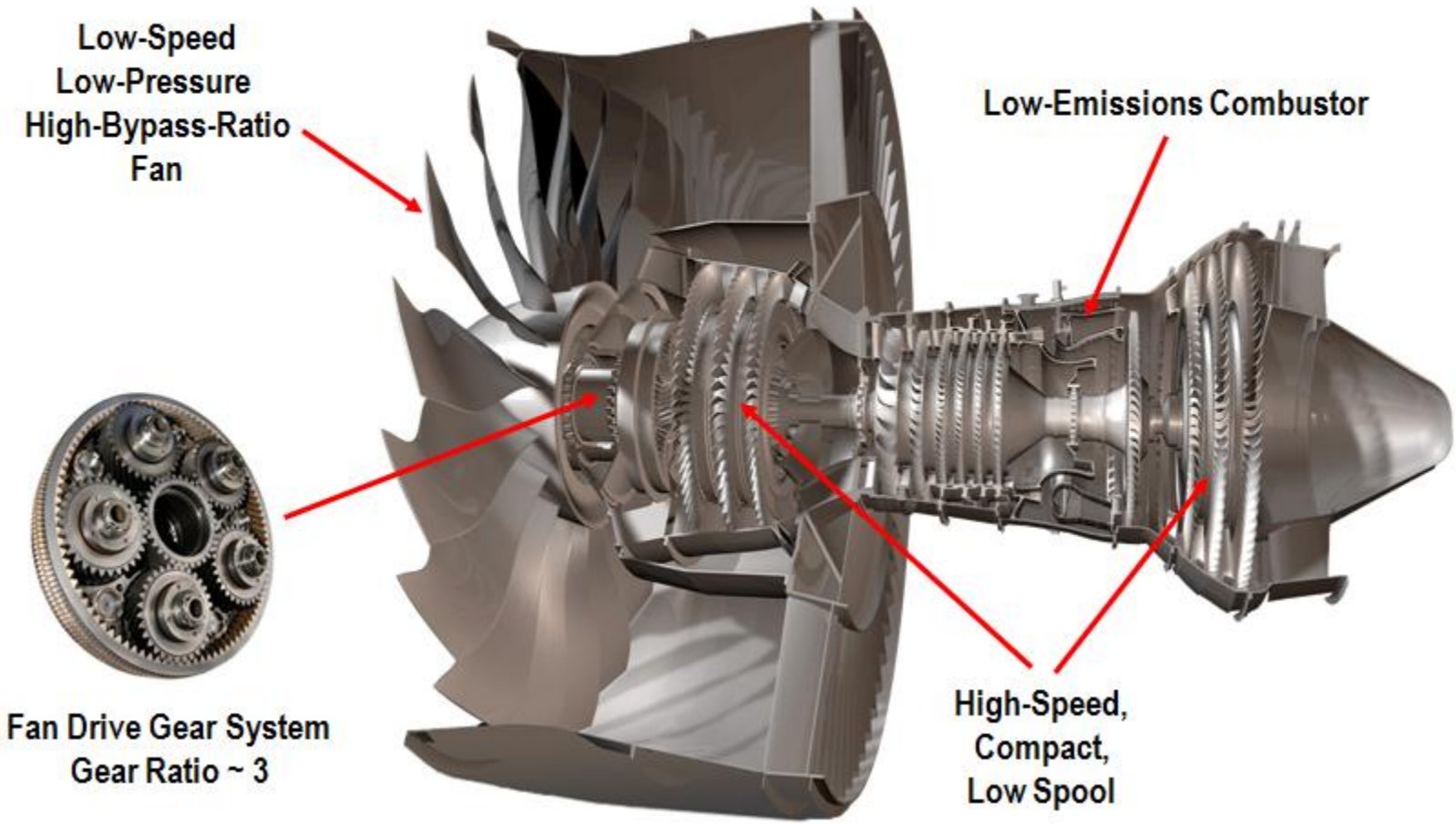


Geared Turbofan Technology Enables Paradigm Shifts



NASA/P&W Partnership on Geared Turbofan Technology

➢ Collaborative Research Technology Areas



GTF Emissions Reduction Goals

Gen 1 (2013 EIS)

	Projected Based on Demonstrated Technology
NOISE (cum margin to Ch 4)	-20 EPNdB
LTO NOX (below CAEP 6)	-60%
FUEL BURN (rel to A320/V2500)	-15%

Gen 2 (2020 to 2025 EIS)

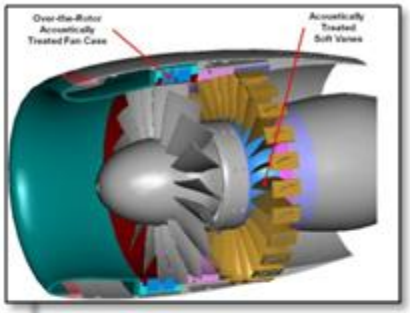
	Projected Based on Demonstrated Technology
NOISE (cum margin to Ch 4)	-25 EPNdB
LTO NOX (below CAEP 6)	-75%
FUEL BURN (rel to A320/V2500)	-25% to -30%

Ultra High Bypass Technology Development Roadmap

GTF Gen 1 Engine
Ground Test Demo

22" GTF NG Tech Dev
Aero/Acoustic Test
GRC 9'x15' WT

22" UHB Advanced OTR / SV
Aero/Acoustic Test
GRC 9'x15' WT

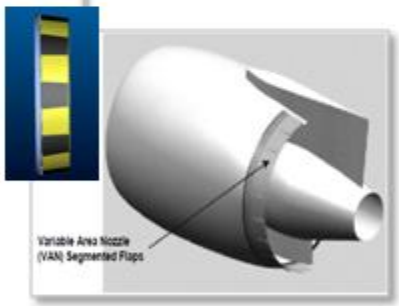


FAA/NASA/P&W
CLEEN Engine Demo

2008 2009 2010 2011 2012 2013 2014 2015

GTF Gen 1 Engine
Flight Test Demo

UHB BPR=18
11% Semi-Span
Nacelle/Wing Installation Test
ARC 11' WT



22" UHB Shaped Memory Alloy
Variable Area Nozzle
Development Test
GRC 9'x15' WT

UHB Technology
Engine Demo

Summary

- *Ultra High Bypass Technology has the potential for significant reductions in fuel burn, noise and emissions*
- *Geared Turbofan Technology can enable these benefits by optimizing fan and core operation and allowing a reasonable engine and core size*
- *The first generation Geared Turbofan was successfully demonstrated under NASA/P&W partnership. Significant contribution toward ERA N+1 Goals was achieved.*
- *A second generation technology to further improve performance to meet ERA N+2 Goals is being planned collaboratively by NASA/P&W. GTF NG technology ground test engine demonstrations are planned as part FAA/NASA/P&W CLEEN partnership in 2014 and possibly 2015*
- *Future long range plans (to 2020) are looking for opportunities to collaboratively conduct engine and flight demonstrations to validate both ERA UHB and P&W GTF NG technologies*