The Promise and Challenges of Ultra High Bypass Ratio Engine Technology and Integration

Summary

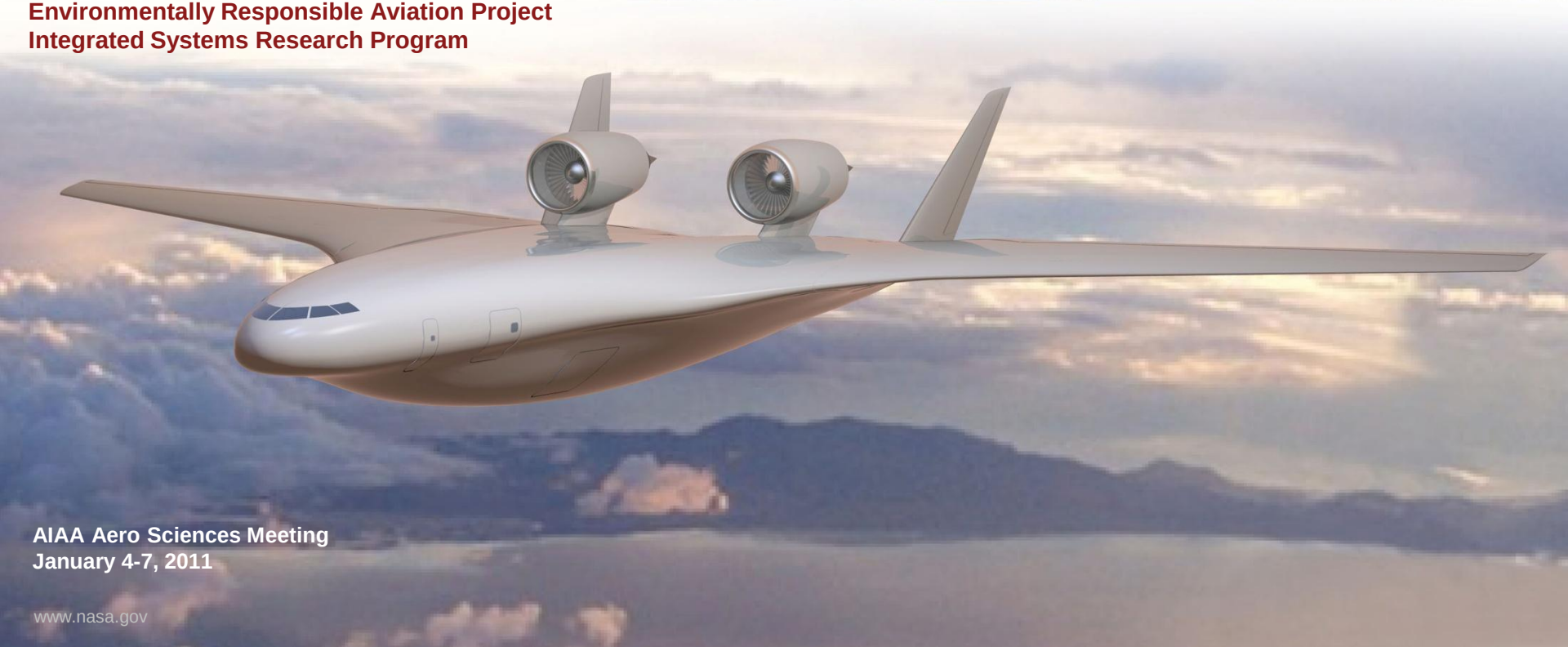
In this presentation, an overview of the research being conducted by the ERA Project in Ultra High Bypass aircraft propulsion and in partnership with Pratt & Whitney with their Geared TurboFan (GTF) is given. The ERA goals are shown followed by a discussion of what areas need to be addressed on the engine to achieve the goals and how the GTF is uniquely qualified to meet the goals through a discussion of what benefits the cycle provides. The first generation GTF architecture is then shown highlighting the areas of collaboration with NASA, and the fuel burn, noise and emissions reductions possible based on initial static ground test and flight test data of the first GTF engine. Finally, a 5 year technology roadmap is presented focusing on Ultra High Bypass propulsion technology research areas that are being pursued and being planned by ERA and P&W under their GTF program.

National Aeronautics and Space Administration

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

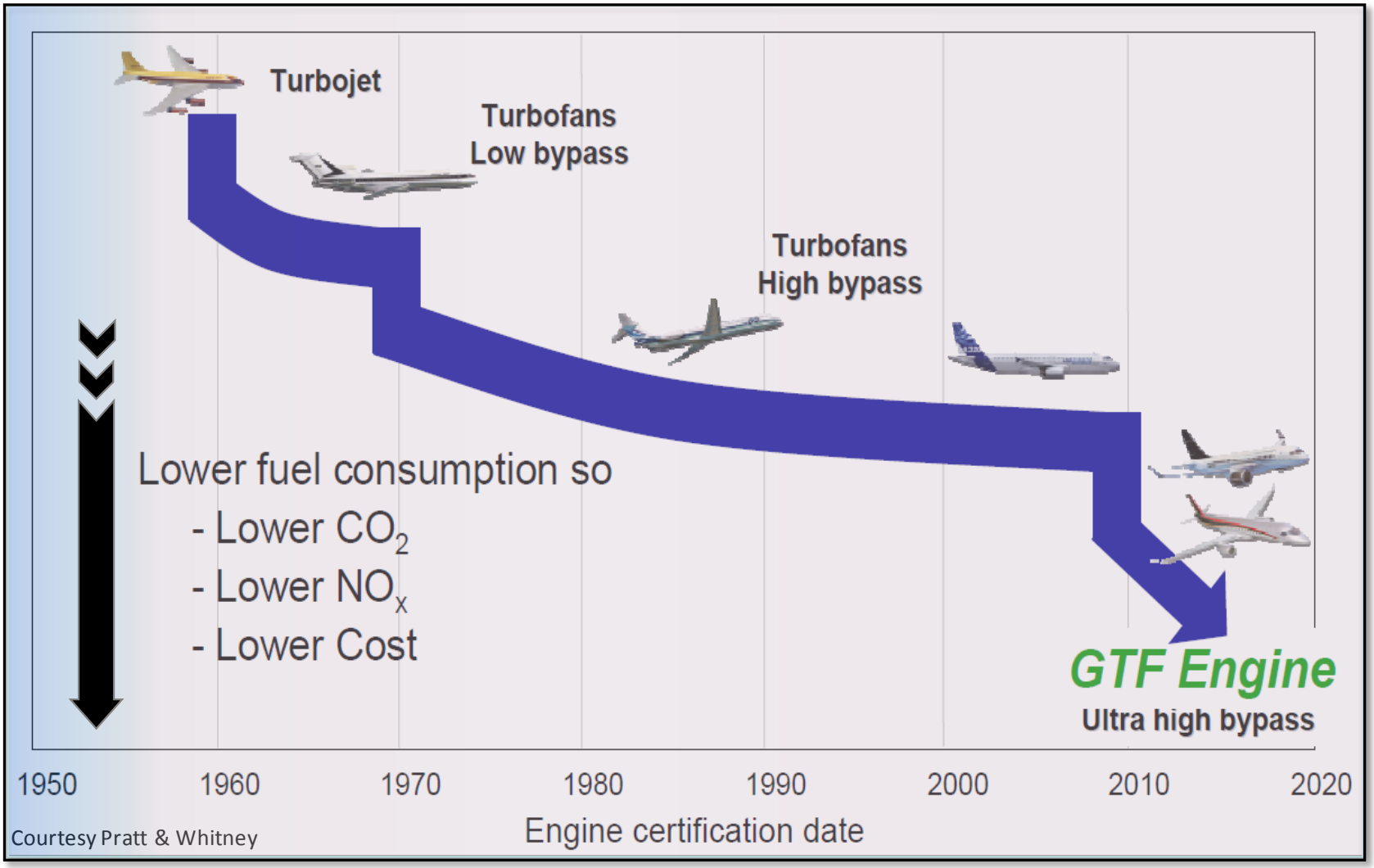
Chris Hughes
Ultra High Bypass Engine Technology Sub-Element
Propulsion Technology Element
NASA Glenn Research Center

Environmentally Responsible Aviation Project
Integrated Systems Research Program



AIAA Aero Sciences Meeting
January 4-7, 2011

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

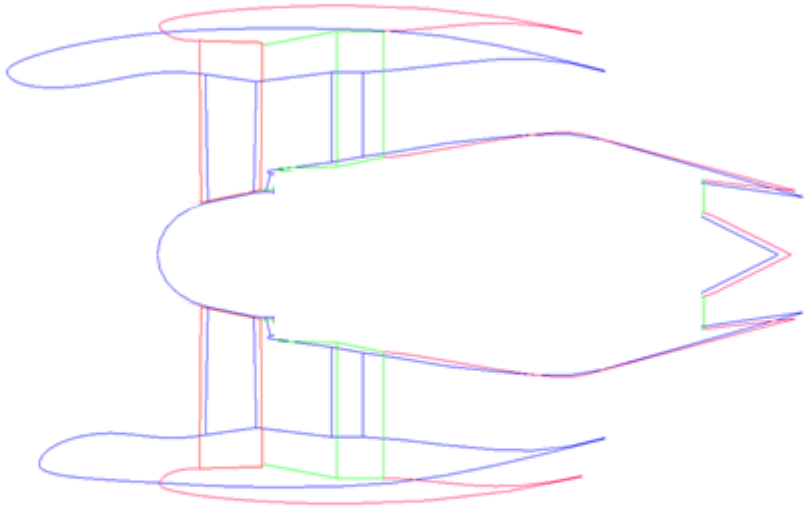
CORNERS OF THE TRADE SPACE	N+1 = 2015*** Technology Benefits Relative To a Single Aisle Reference Configuration	N+2 = 2020*** Technology Benefits Relative To a Large Twin Aisle Reference Configuration	N+3 = 2025*** Technology Benefits
Noise (cum below Stage 4)	-32 dB	-42 dB	-71 dB
LTO NO_x Emissions (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

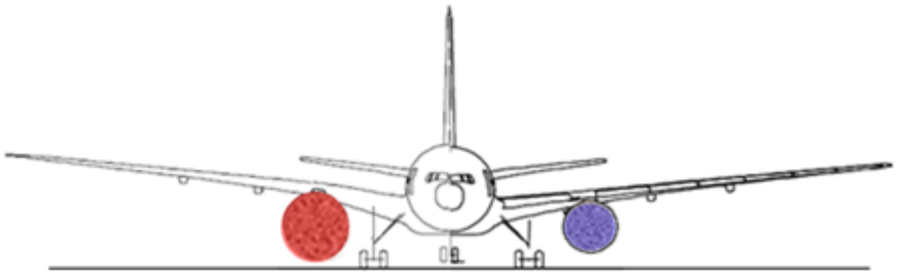
- ***Thrust Specific Fuel Consumption – Need Higher Propulsive Efficiency, Which is Achieved with Higher Bypass Ratio, Lower Fan Pressure Ratio***

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

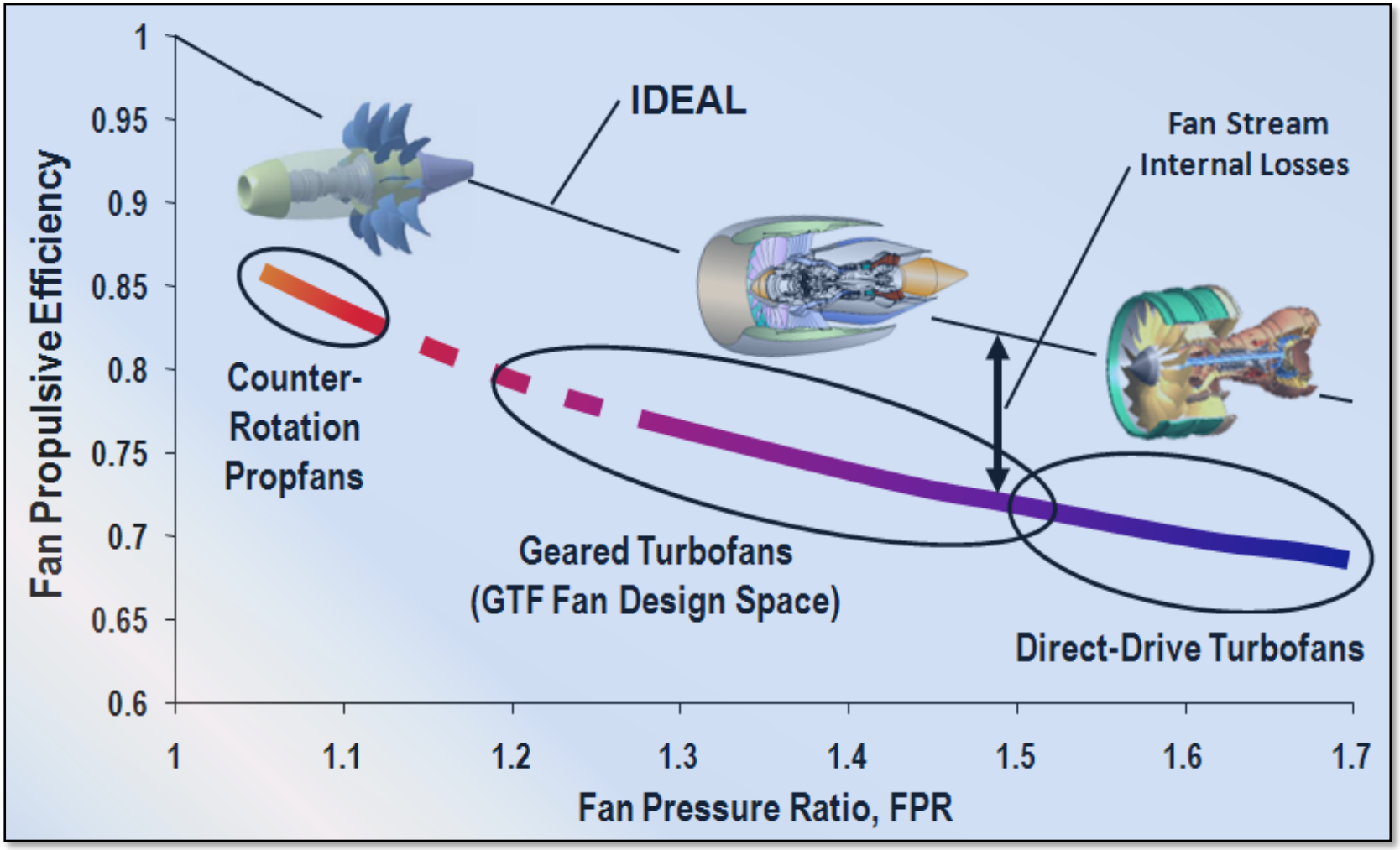


- ***Nacelle Drag – Need Thinner, Shorter Nacelles as Engine Bypass Ratio and Fan Diameter Grow***

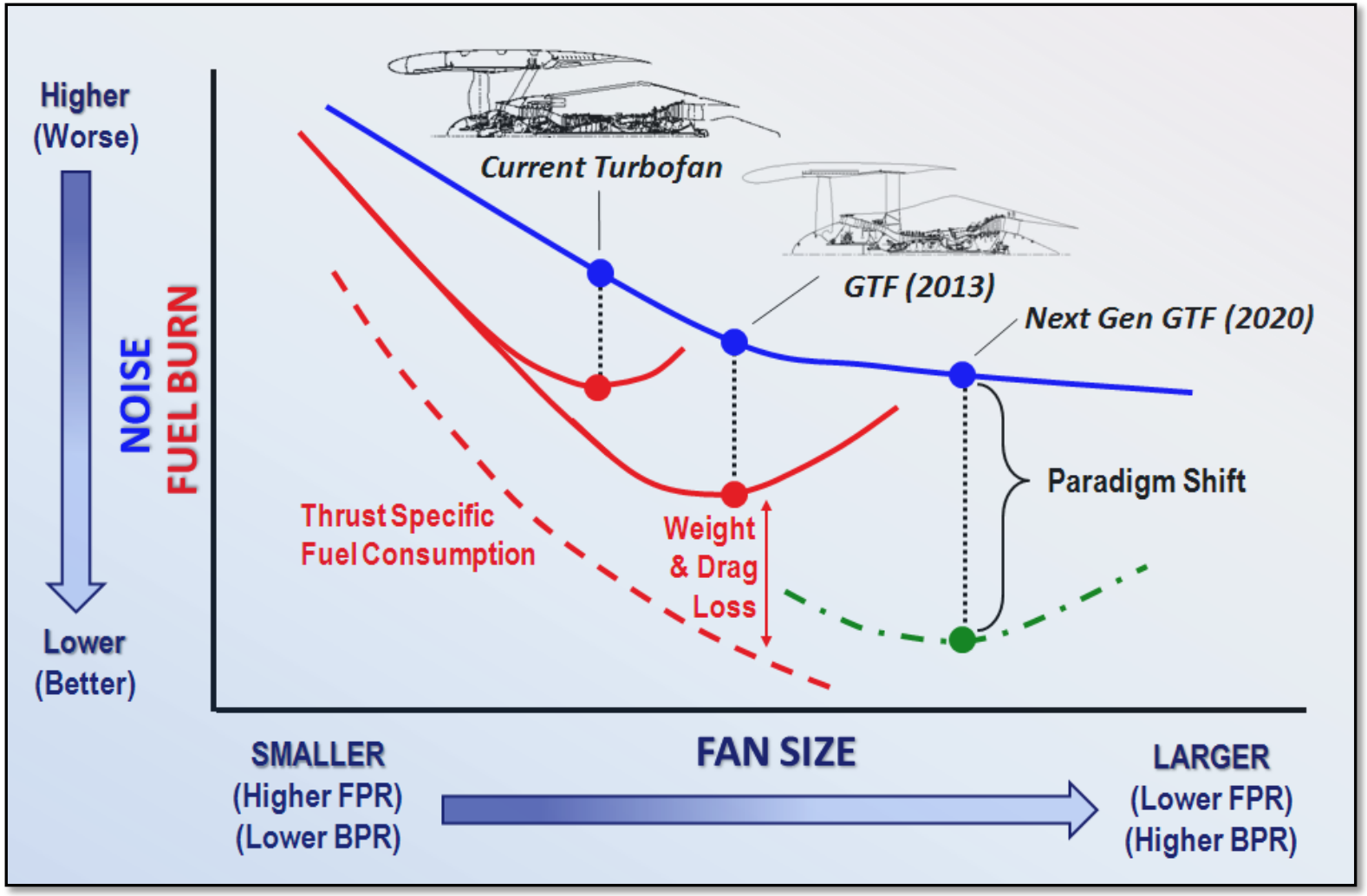
- ***Installation – Need Special Designs to Integrate Bigger Engines and Minimize Impact on Aircraft Performance***



Propulsive Efficiency Trend with Fan Pressure Ratio

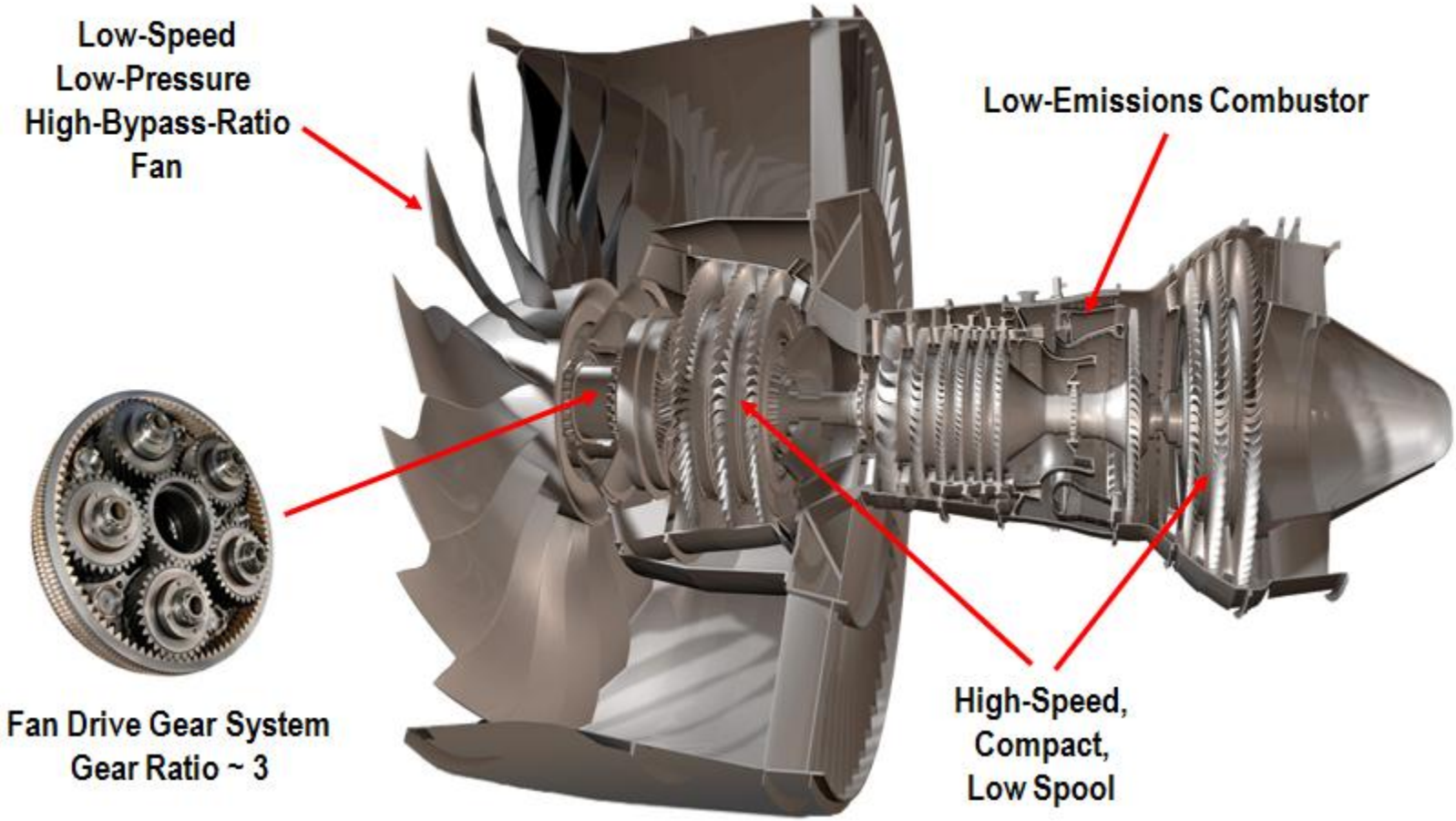


Geared Turbofan Technology Enables Paradigm Shifts



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)

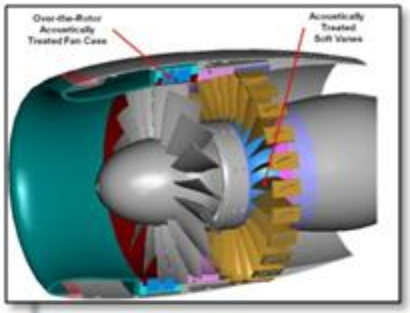
	Projected Based on Demonstrated Technology
NOISE (cum margin to Ch 4)	-25 EPNdB
LTO NOX (below CAEP 6)	-75%
FUEL BURN (rel to A320/V2500)	-25% to -30%

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

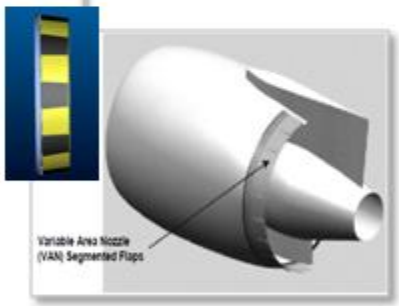


FAA/NASA/P&W
CLEEN Engine Demo

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*