

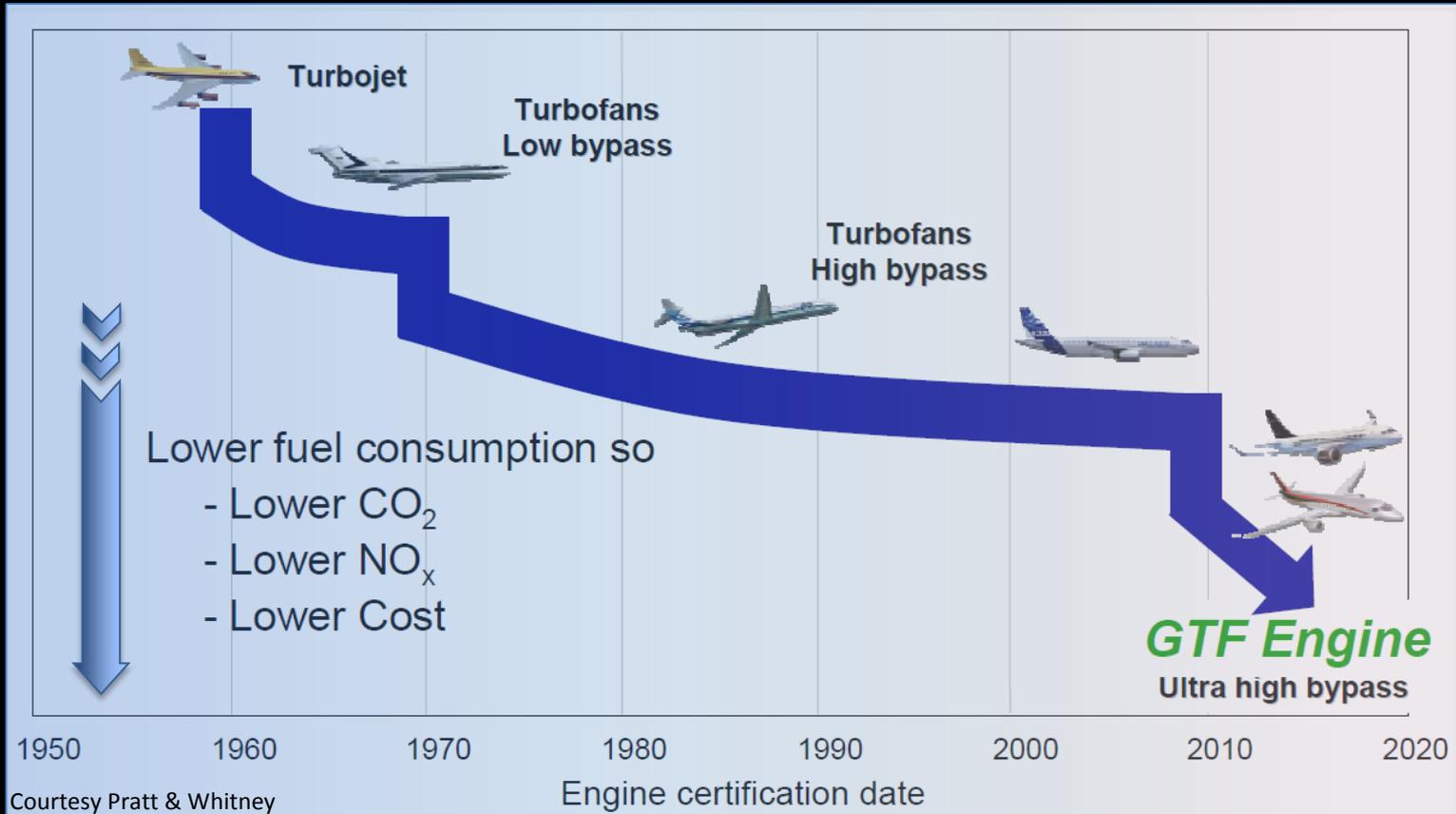


Geared Turbofan Technology

Chris Hughes
**NASA Environmentally
Responsible Aviation Project**

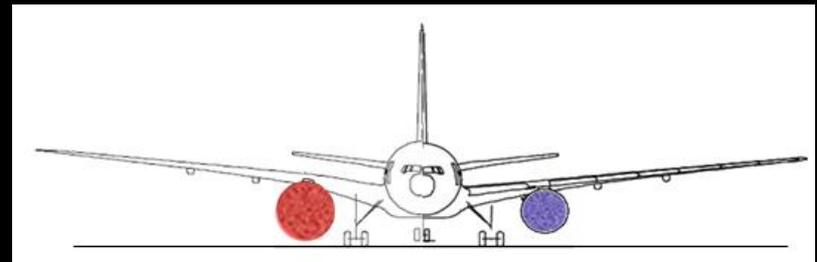
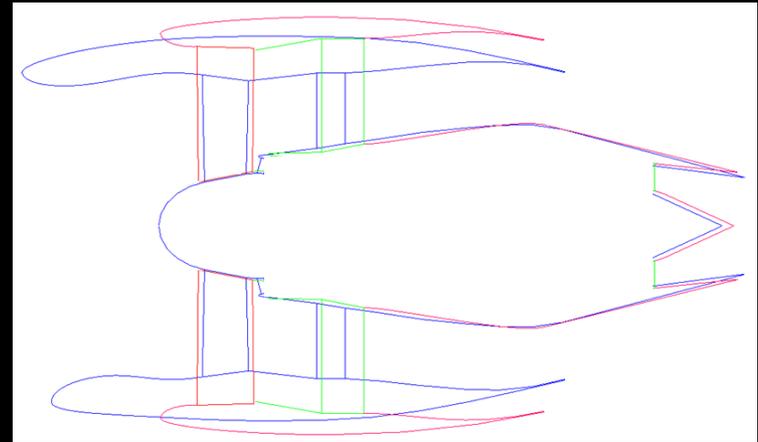
Green Aviation Summit
NASA Ames Research Center
September 8-9, 2010

Geared Turbofan Technology Enables a Step-Change in Ultra High Bypass Propulsion

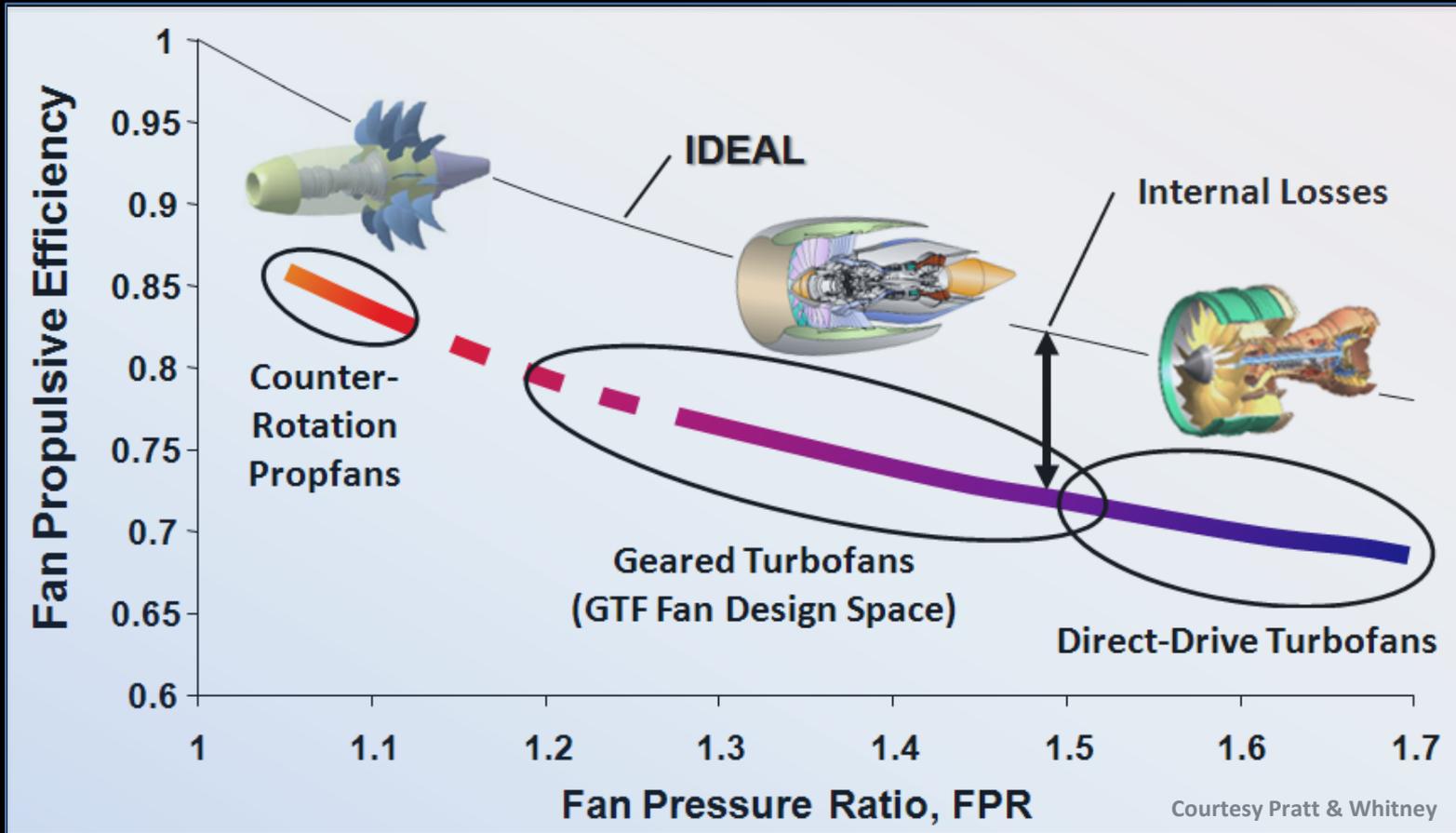


Propulsion System Fuel Burn Drivers

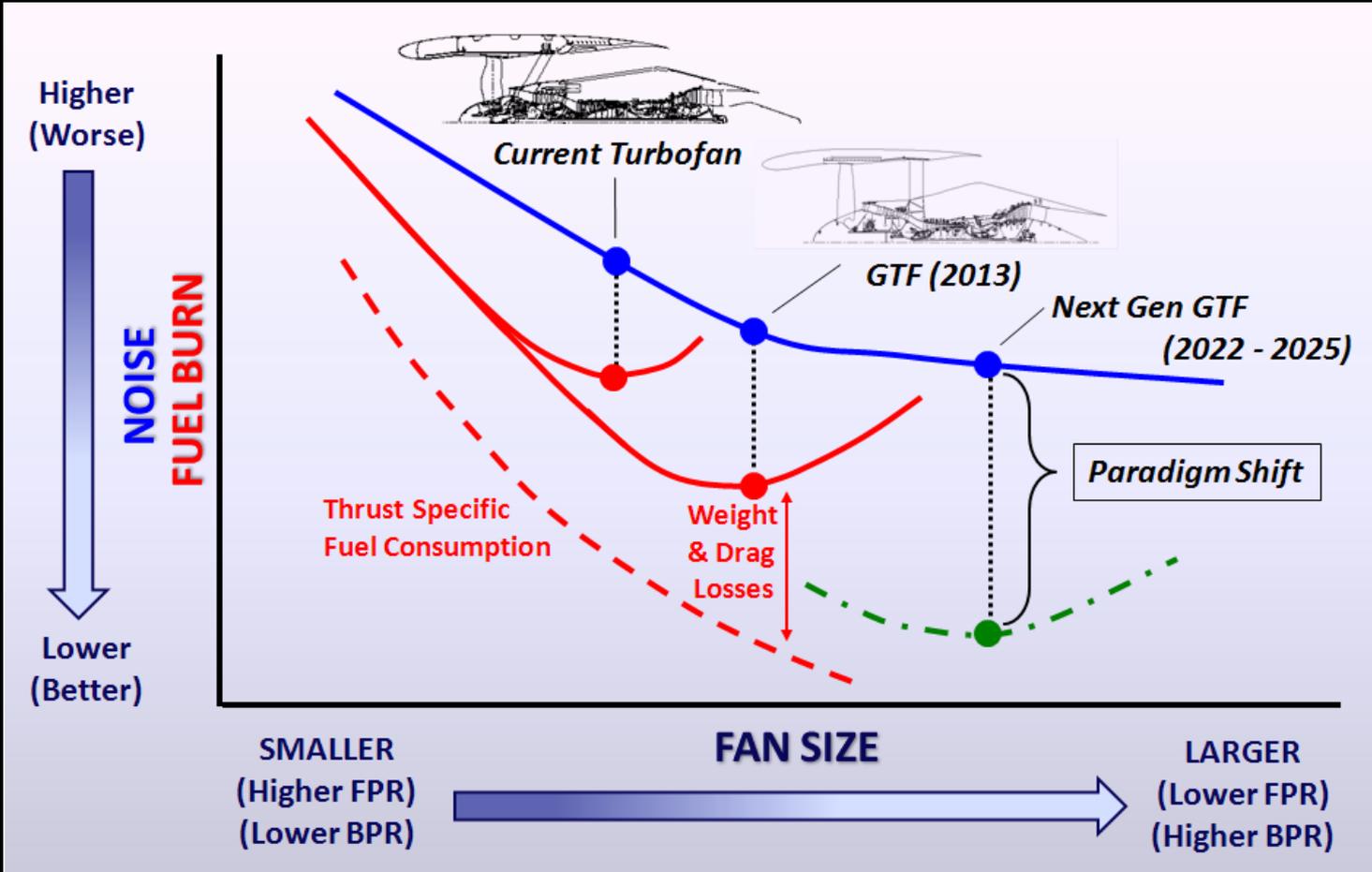
- ***Thrust Specific Fuel Consumption – Need Higher Propulsive Efficiency, Which is Achieved with Higher Bypass Ratio***
- ***Weight – Need Advanced, Lighter Materials; Advanced, Smaller Components; More Compact Designs***
- ***Nacelle Drag – Need Thinner, Shorter Nacelles as Engine Bypass Ratio and 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

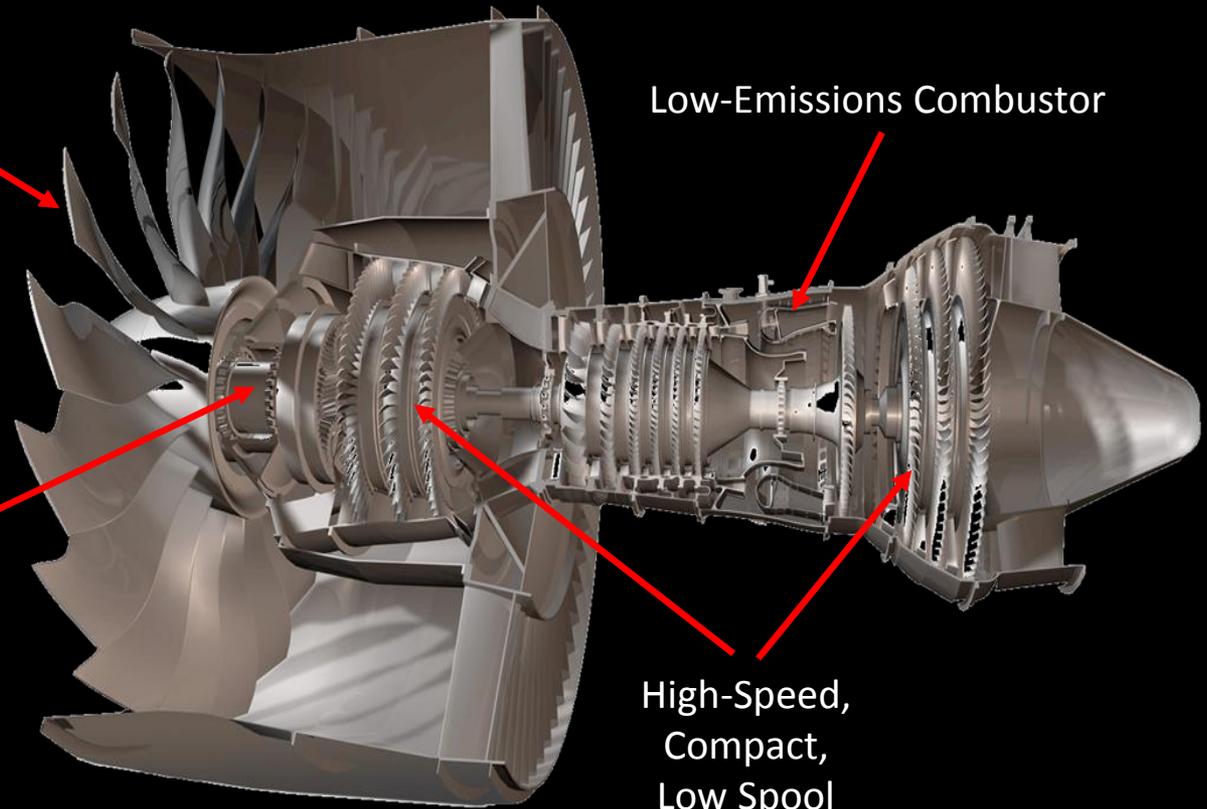


NASA/P&W Partnership on Geared Turbofan Technology

Low-Speed
Low-Pressure
High-Bypass-Ratio
Fan



Fan Drive Gear System
Gear Ratio ~ 3



Low-Emissions Combustor

High-Speed,
Compact,
Low Spool

Ultra High Bypass Technology Development Roadmap

GTF Gen 1 Ground Test Demo



2008

GTF Gen 2 Aero/Acoustic Wind Tunnel Test



2009

2011

2012

GTF Gen 1 Entry Into Service



2013

2014

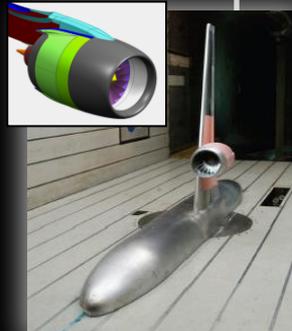
FAA/NASA/P&W CLEEN Engine Demo



2015



GTF Gen 1 Flight Test Demo



UHB Nacelle/Wing Installation Test



UHB Shaped Memory Alloy Variable Area Nozzle Development



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 while allowing a reasonable engine and core size*
- *The first generation Geared Turbofan was successfully demonstrated by NASA and P&W partnership, and P&W will enter it into service with aircraft manufacturers in 2013*
- *A second generation technology to further improve performance is being investigated collaboratively by NASA/P&W, with a planned FAA/NASA/P&W engine demonstration in 2014*