Propulsion Technology Direction

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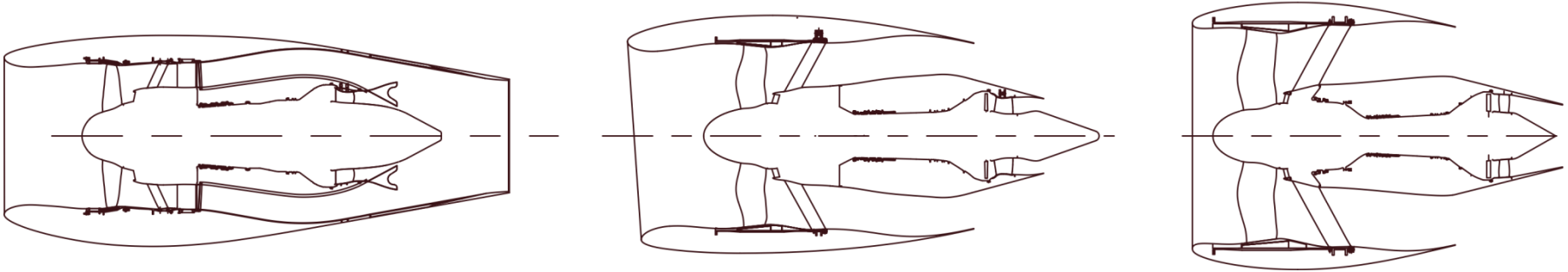
Propulsion Technology Direction

Short/Medium Range
In Service
BPR 5
Fuel Burn Reference

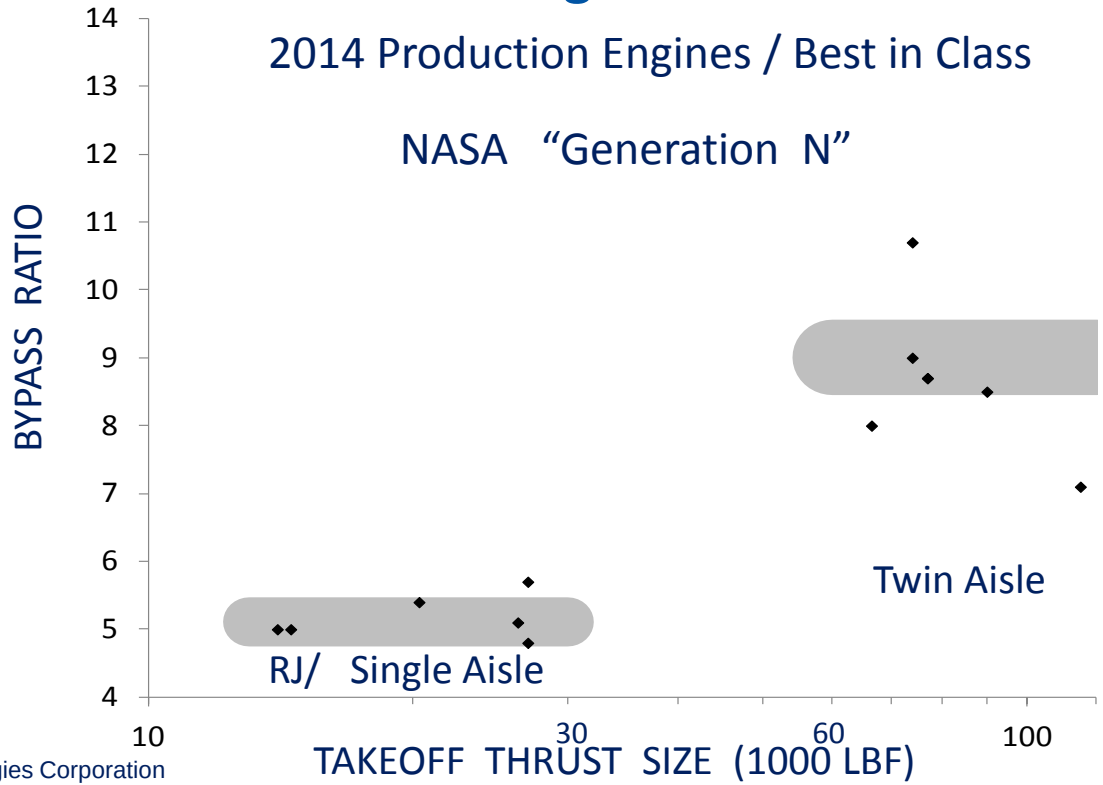
2015-19
BPR ~12
-15%

Longer Term
BPR 15~18
-20~30%

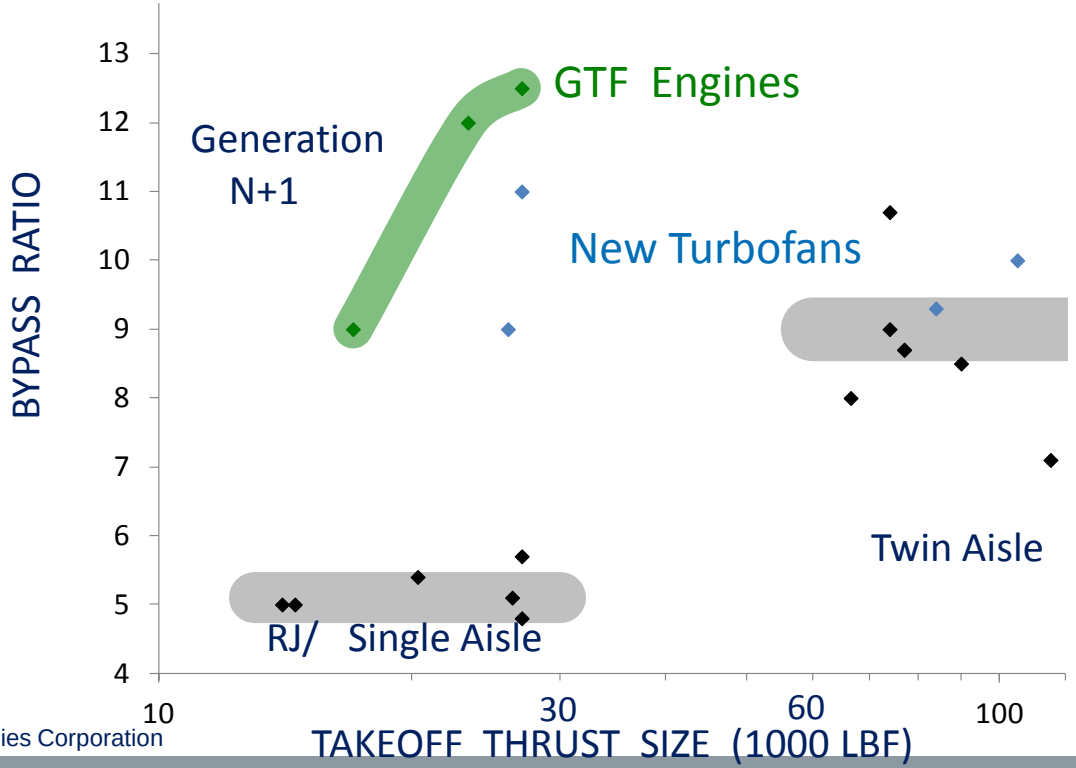


Propulsion Trend to Big Fans/ Small Cores

BPR of Current Engines vs Thrust Size

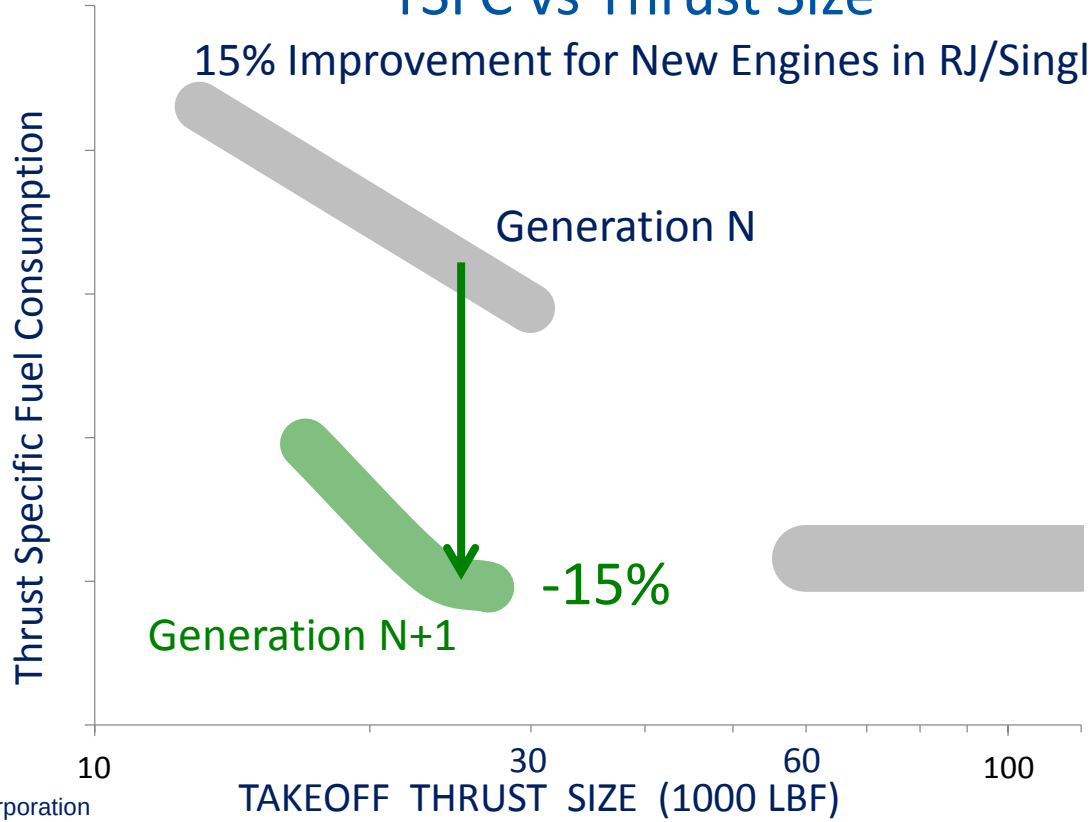


BPR vs Thrust Size Including New Engines EIS 2015-2020

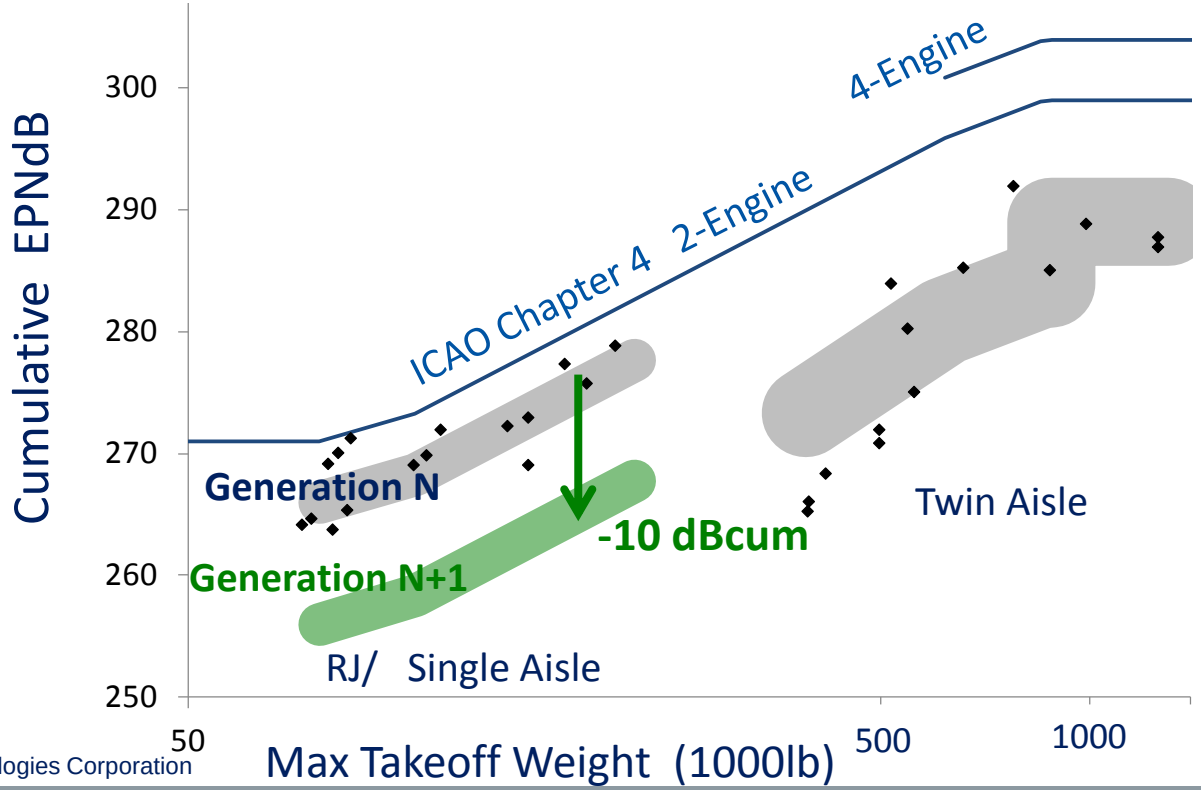


TSFC vs Thrust Size

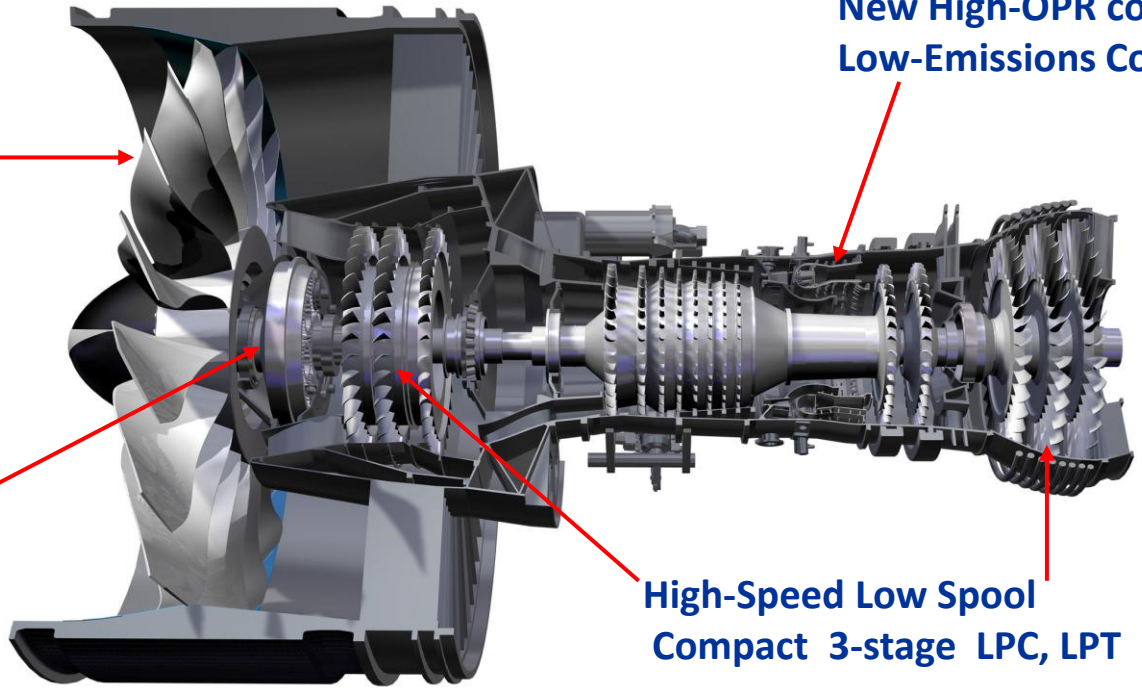
15% Improvement for New Engines in RJ/Single Aisle Class



Noise -10dBcum Improvement for New Engines in RJ/Single Aisle



GTF Engine Architecture – 2015 Configuration BPR = 12



Low-PR Fan
Low Tip Speed

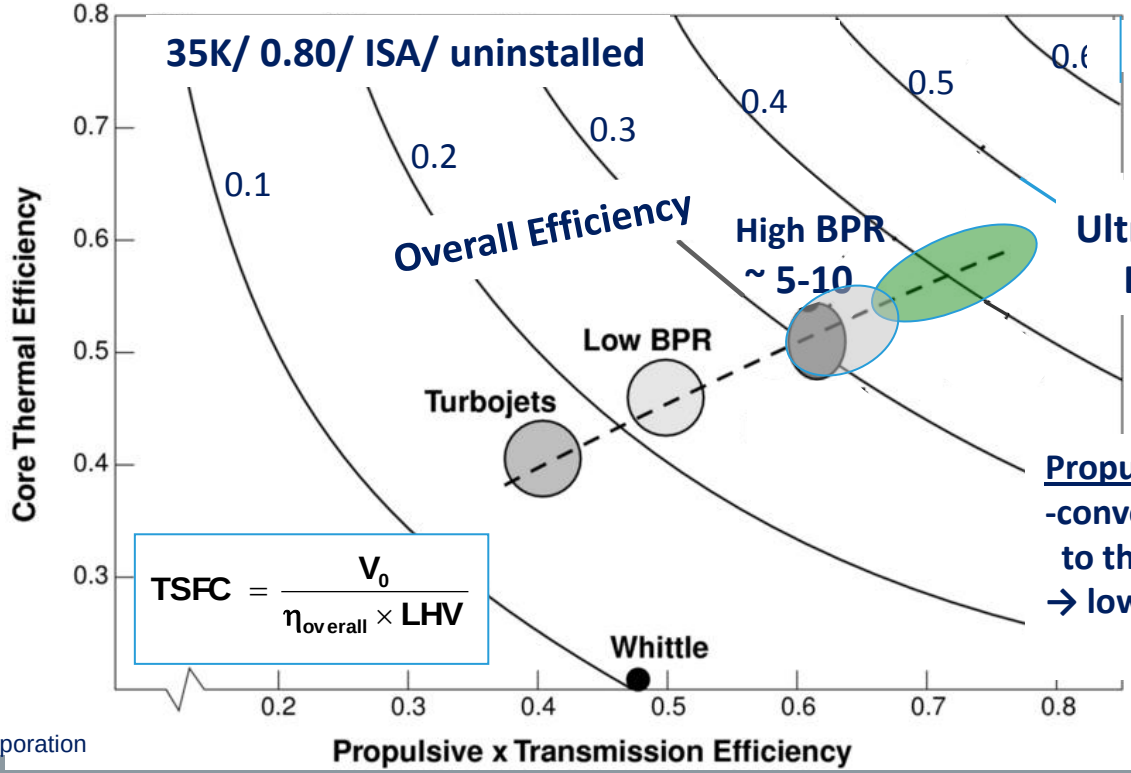
New High-OPR core
Low-Emissions Combustor

Fan Drive Gear System
Compact High Efficiency

High-Speed Low Spool
Compact 3-stage LPC, LPT

Performance Trend to Higher OPR , Lower FPR

Thermal Efficiency
-production of power from fuel heat release
→ increase Overall Pressure Ratio (OPR)

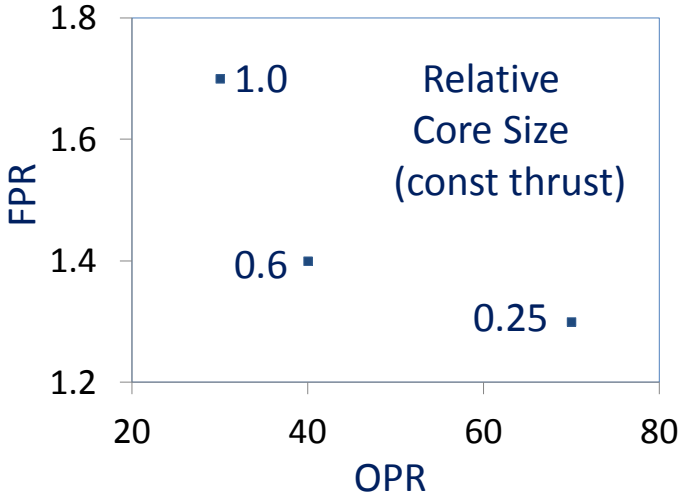


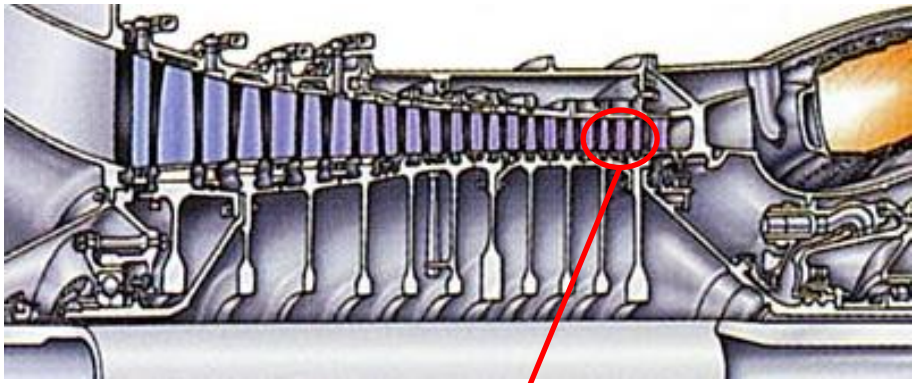
Propulsive Efficiency
-conversion of power to thrust
→ lower Fan Pressure Ratio (FPR)

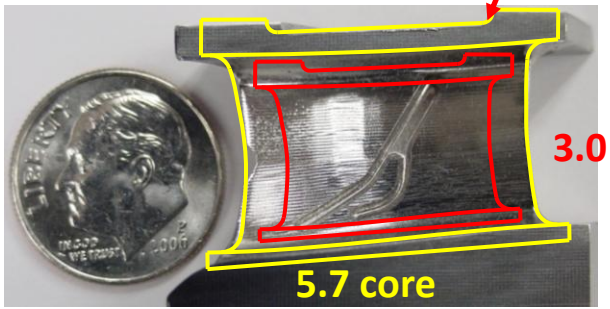
"Core Size" Design Issue for High-OPR Engines

Compressor exit corrected flow "core size"

$$\frac{W\sqrt{\theta}}{\delta}$$

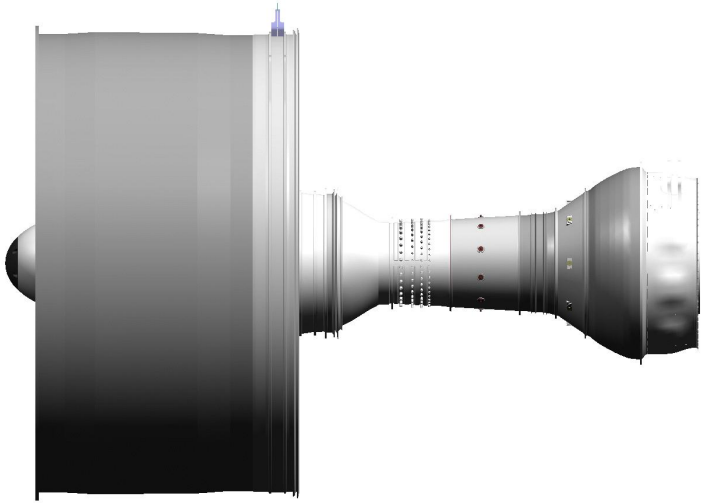






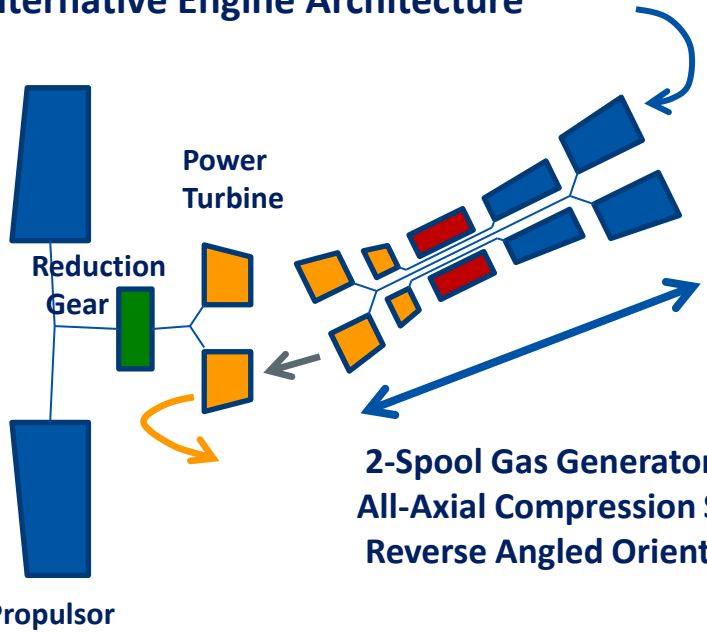
Engine Architecture Design Issues for UHB propulsion

Study GTF Engine at BPR=18



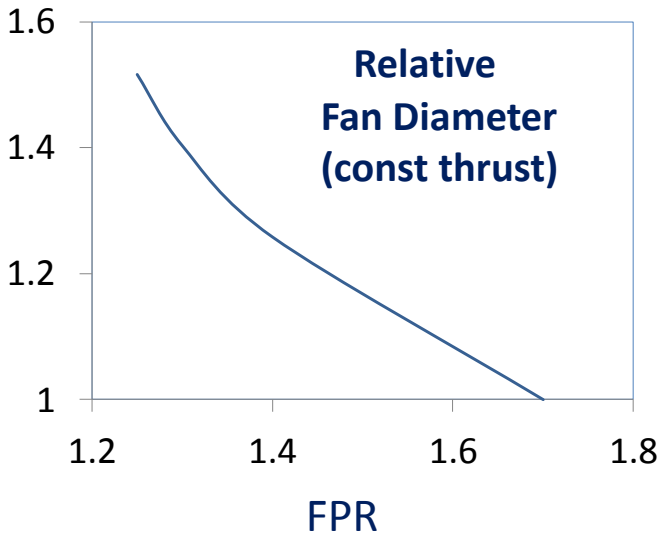
Design Issues: **blade height at HPC exit**
fan drive shaft through small core
backbone bending of case structure

Alternative Engine Architecture



2-Spool Gas Generator
All-Axial Compression System
Reverse Angled Orientation

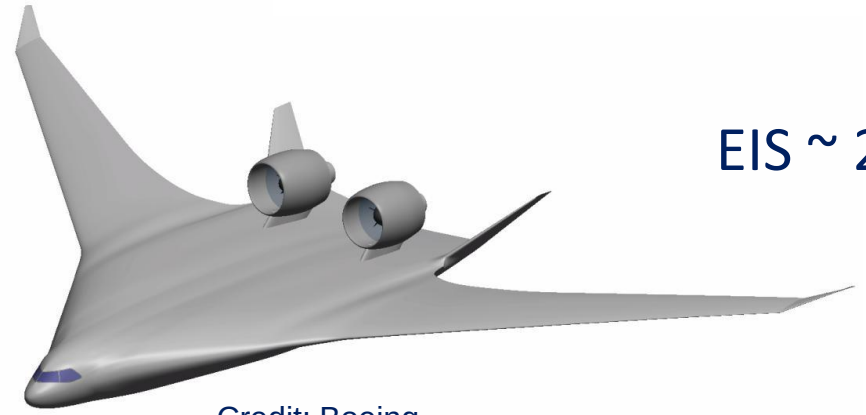
Installation Challenge for Low-FPR/ High-BPR Engines



Current 5:1 BPR

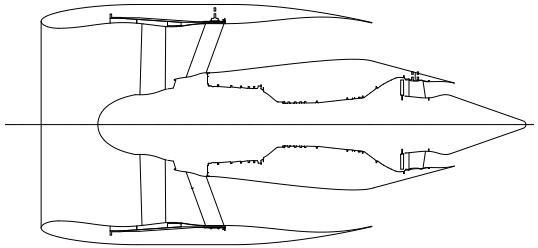
Future 18:1 BPR

N+2 Boeing BWB Aft Fuselage Installation



Credit: Boeing

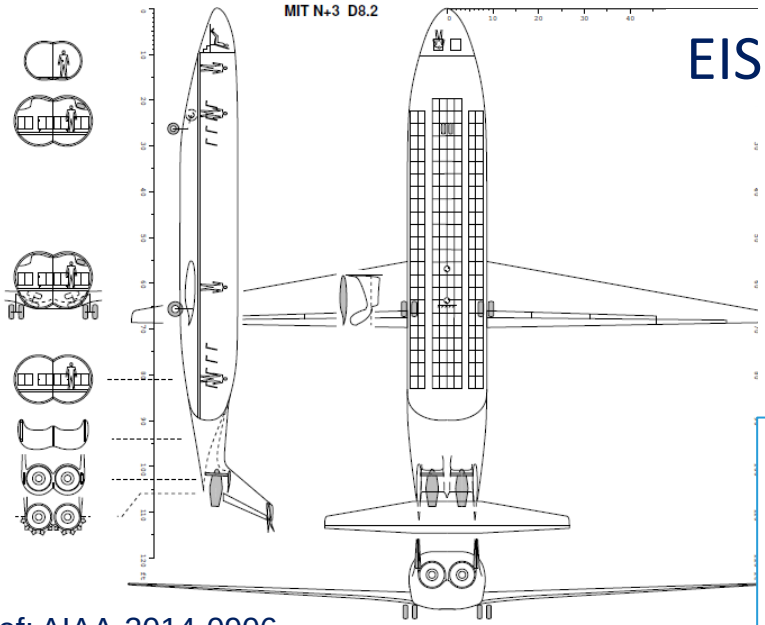
EIS ~ 2025



Engine Takeoff Thrust Size 50K lbf
GTF Engine Architecture
BPR ~ 13

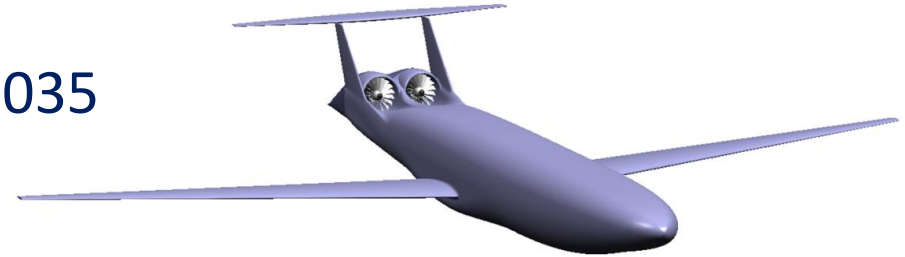
NASA N+2 Goals	
Fuel Burn	-50% (Ref: 777/GE90)
Noise	Ch4 – 42 EPNdBcum
LTO NOX	CAEP/6 – 75%

N+3 MIT D8 (Double-Bubble) Configuration



Ref: AIAA-2014-0906

EIS ~ 2035



Engine Takeoff Thrust Size 15K lbf
Boundary Layer Ingesting Propulsion
BPR ~ 20+

NASA N+3 Goals

Fuel Burn	-60% (Ref: 737-800/CFM56)
Noise	Ch4 – 52 EPNdBcum
LTO NOX	CAEP/6 -80%

Propulsion Technology Direction - Summary

- -15% fuel burn and -10 dBcum enabled by new technology engines on regional jet and single-aisle aircraft 2015-2020
- Longer term goal -20 to -30% fuel burn contribution from engines (2025+)
- Future propulsion design challenges involve small cores and big fans -alternative architectures at engine and vehicle level may be required