

KEY REQUIREMENTS FOR AIRCRAFT ENGINES

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Trusted to deliver excellence

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Rolls-Royce

Rolls-Royce product sectors



Civil Aerospace

Our engines keep up 400,000 people in the air at any one time

Defence Aerospace

160 armed forces around the world depend on our engines

Marine

30,000 commercial and naval vessels use our marine equipment

Power Systems

Reciprocating engines for propulsion and distributed energy systems

Nuclear

Design authority for the Royal Navy's naval nuclear plant



Rolls-Royce in numbers

- 5 major businesses
- 10 seconds between take offs
- 200 countries host our customers
- 4500+ large engines are operating today
- 51,000 employees deliver this in OE and services
- 400,000 people in the air relying on our products every moment

2015 financials

order book £76,4 billion	underlying Group revenue £13,4 billion	underlying profit £1,43 billion
Original Equipment: 48%		Services: 52%



Research and development

We develop technologies and intellectual property that provide competitive advantage in our chosen markets.

£1,235m

Invested in
Research and
Development in
2015

624

Patent
applications in
2015

31

University
Technology
Centres
worldwide



Invent once, use many times



- Titanium swept hollow fan is a key technology for the Trent 1000



T1000 Swept Hollow Fan

- Combined into a friction-welded blisk, it powers the Joint Strike Fighter



JSF Lift Fan



Rolls-Royce

Key Requirements

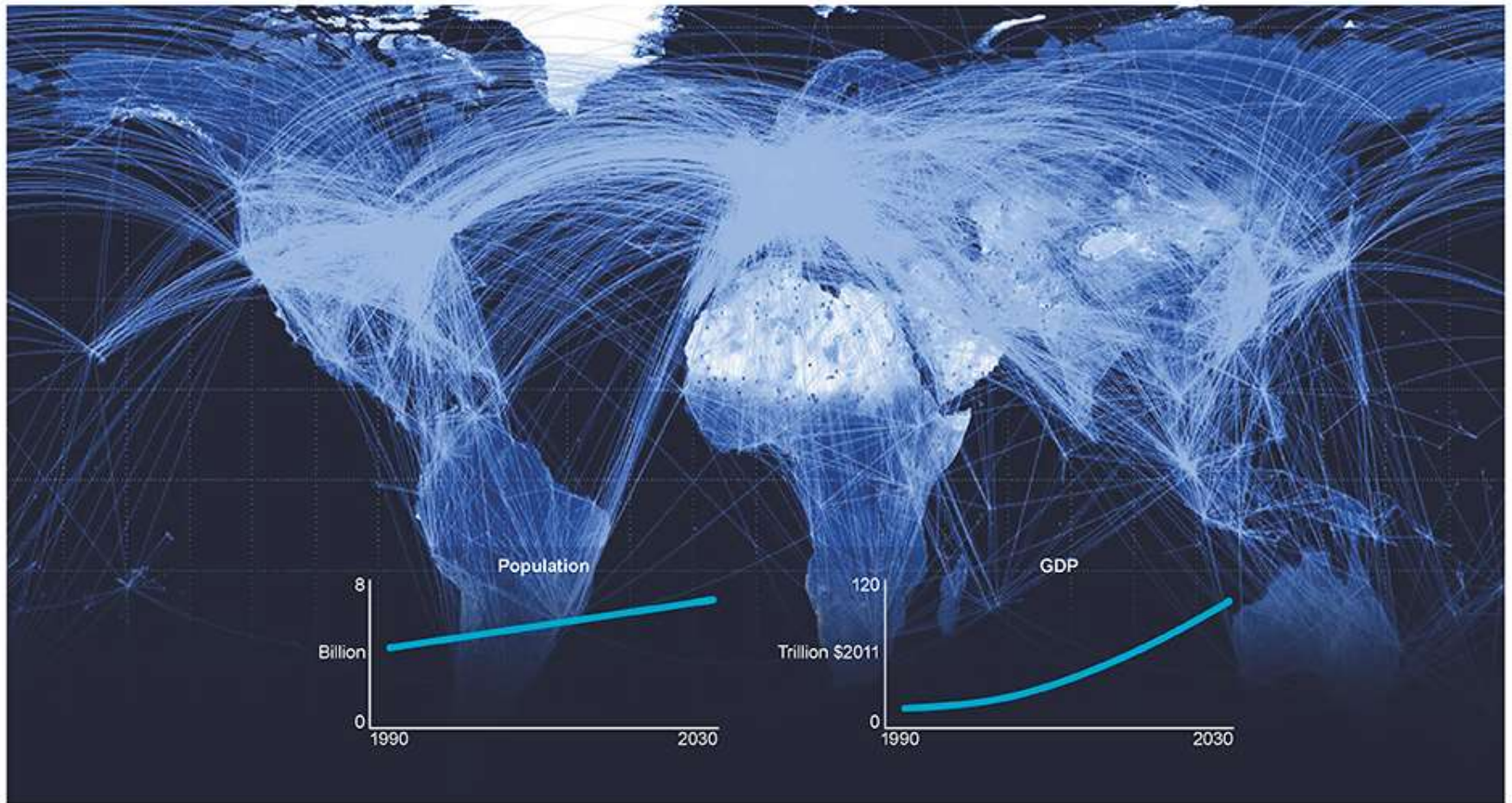
- **Reliable Partnership**
- **Competitive, reliable products**
- **Cutting edge, proven technologies**
- **Integration capability and systems engineering on highest level**
- **World class servicing network and capabilities**
- **Solid industrialisation base and supply chain**
- **Ability to contribute to complex, multi-decade programmes and endeavours on global scale**

.....and.....

‘It shall weigh nothing, cost nothing, use no fuel, have infinite life and clean the air as it flies along.....’



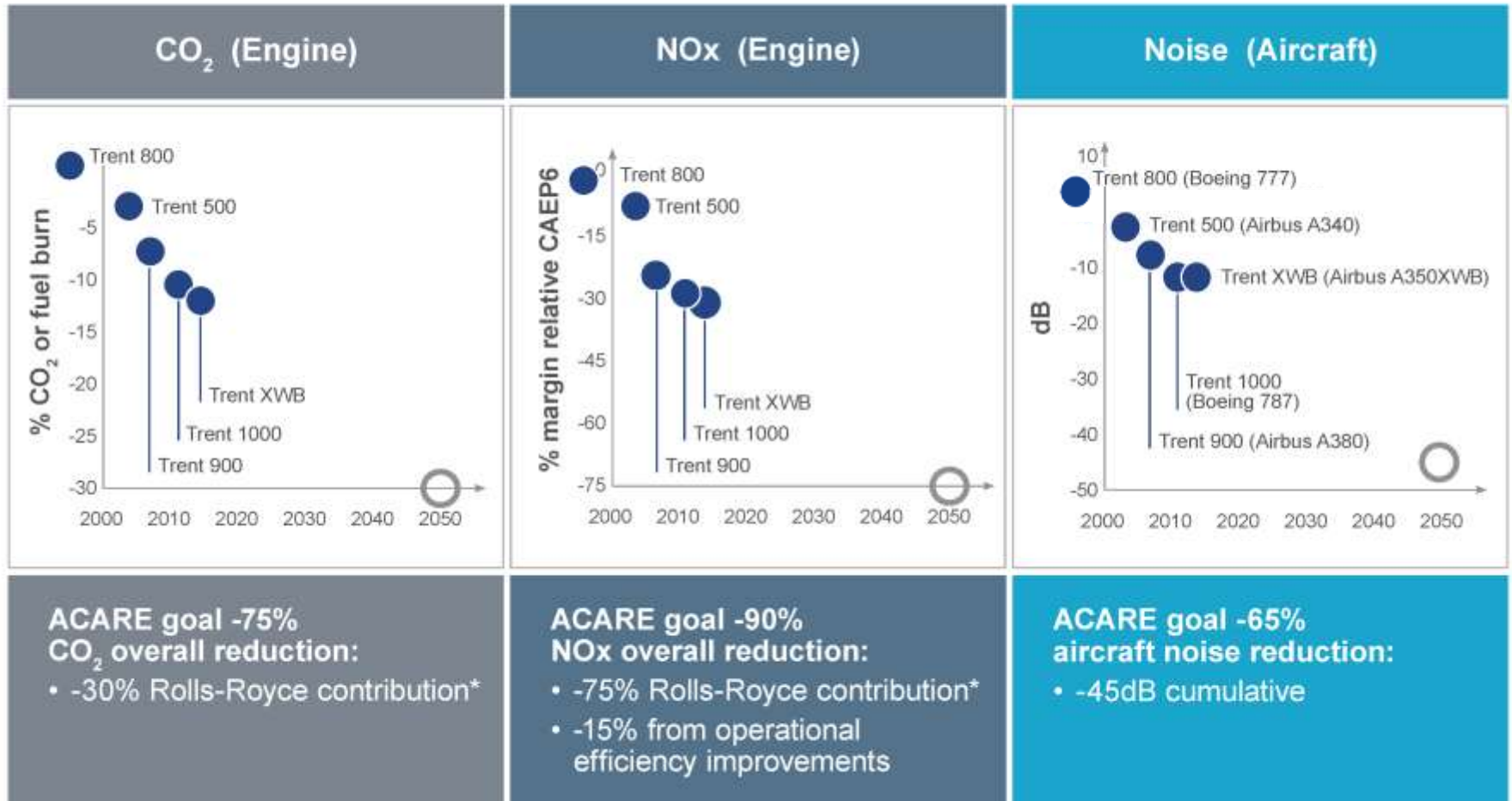
Opportunity



Sources: Mark Litwintchik, Wikipedia, NASA



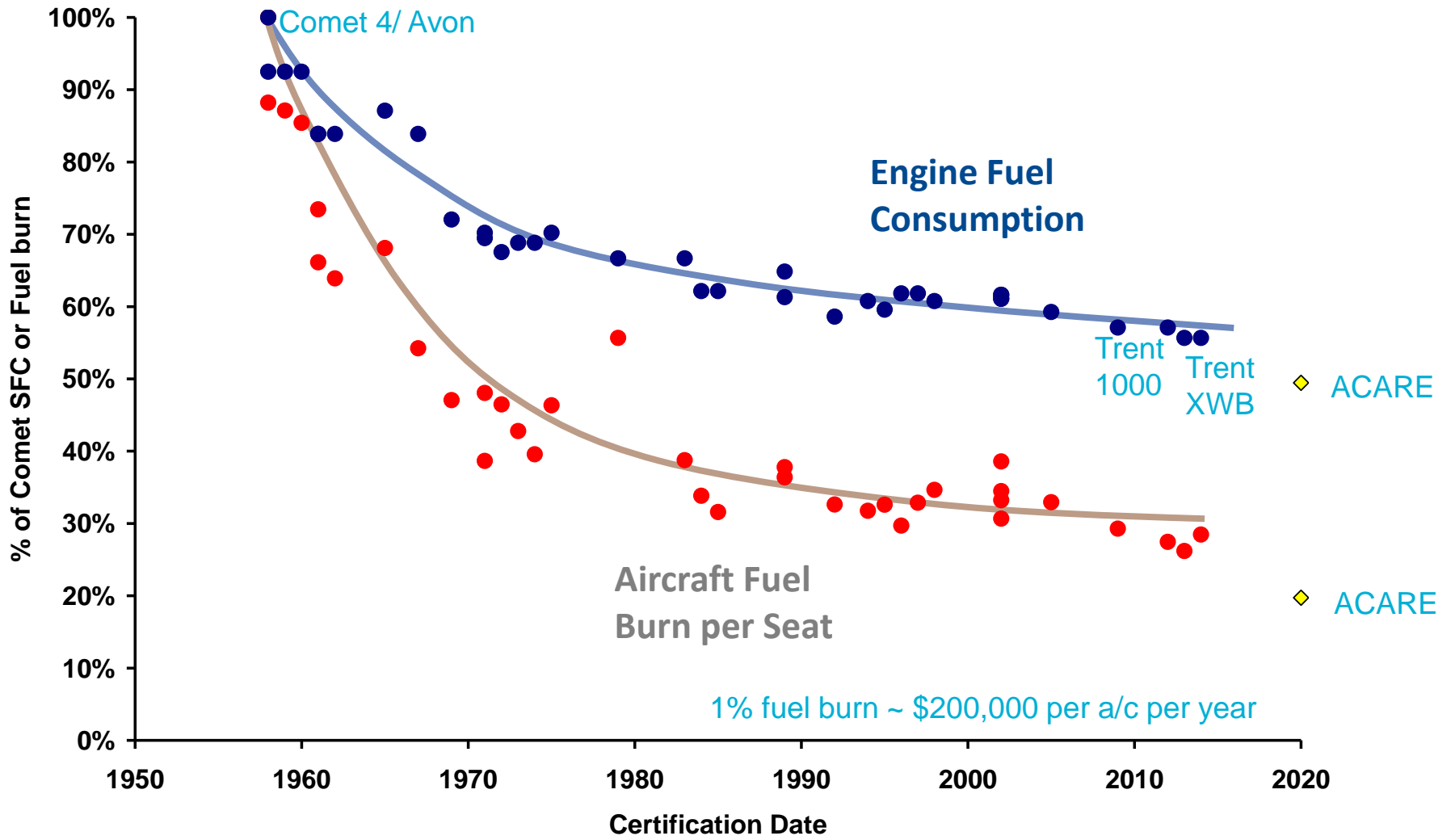
And we've made great progress so far



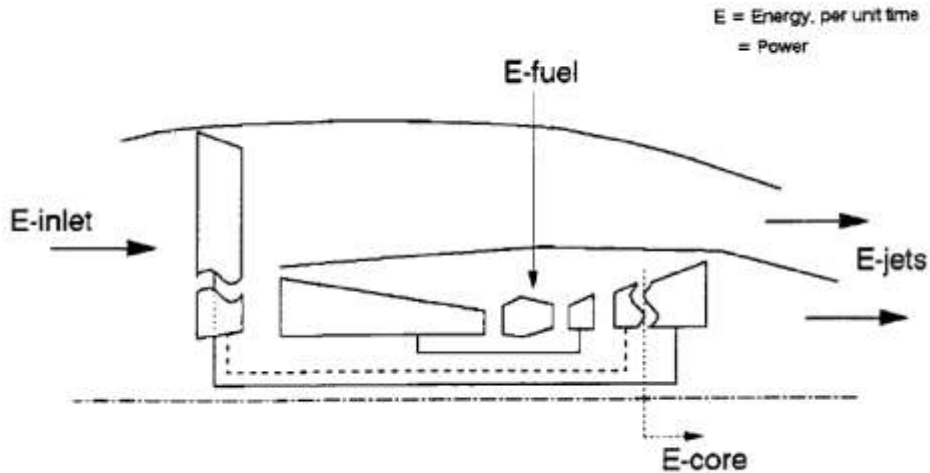
*Rolls-Royce provisional estimate - definitive ACARE level TBD

● Trent family ○ ACARE (Advisory Council for Aviation Research and Innovation in Europe) Flightpath 2050 target

Fuel efficiency of long range aircraft



Some basics

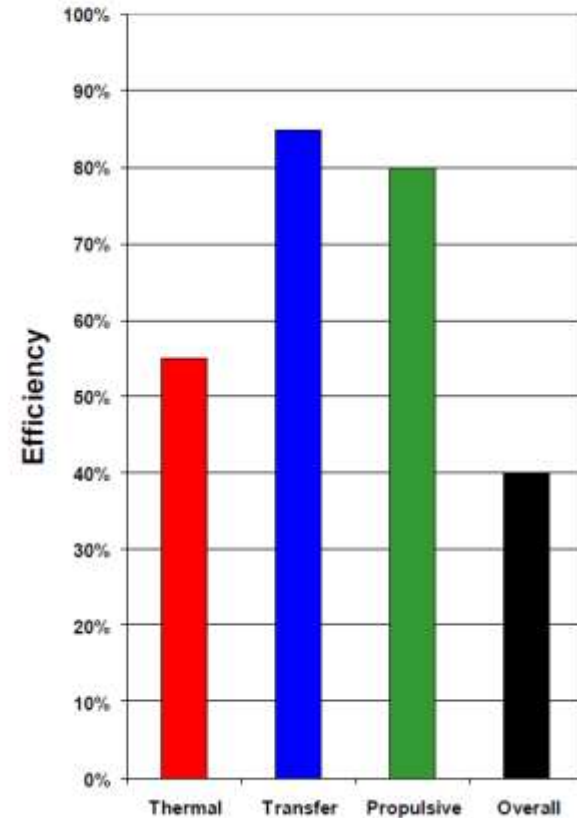


Core thermal efficiency = $E\text{-core}/E\text{-fuel}$

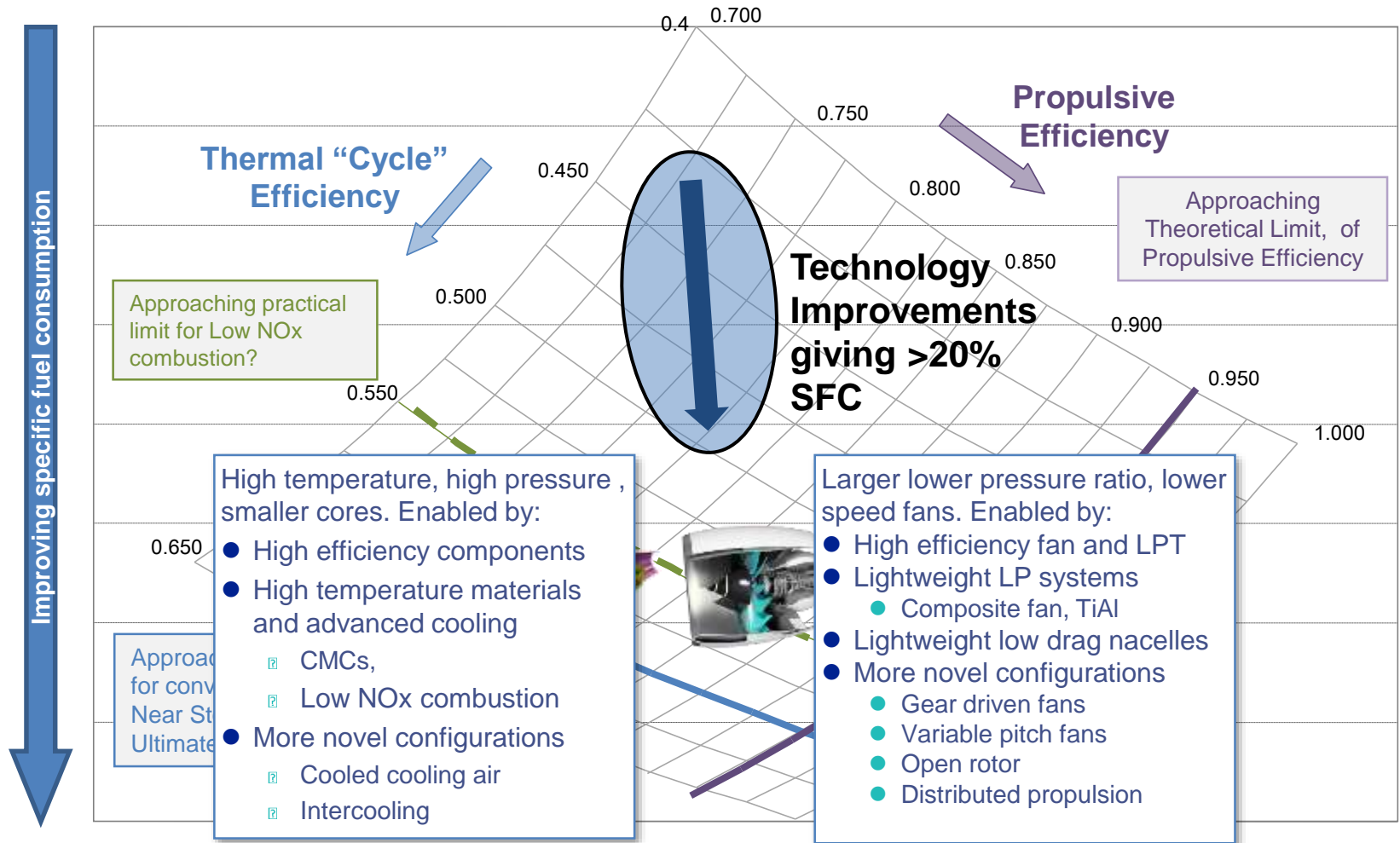
Transfer efficiency = $(E\text{-jets} - E\text{-inlet})/E\text{-core}$

Propulsive efficiency = $F_n \cdot V_0 / (E\text{-jets} - E\text{-inlet})$








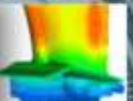



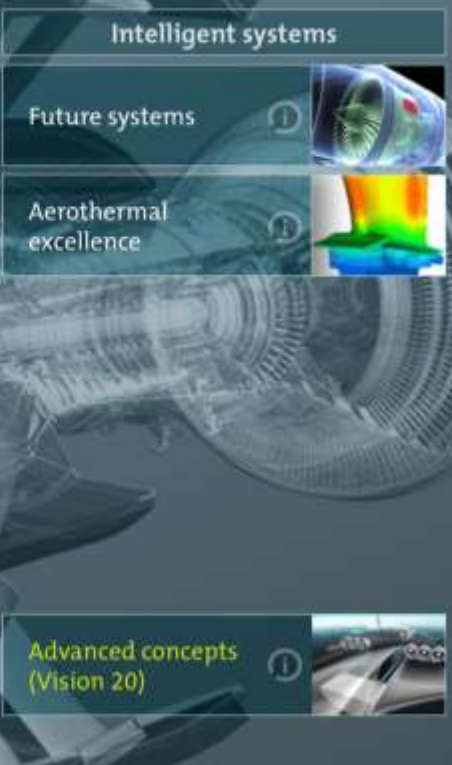






State-of-the-Art Turbofan Cycle Efficiencies



Driving for higher efficiency

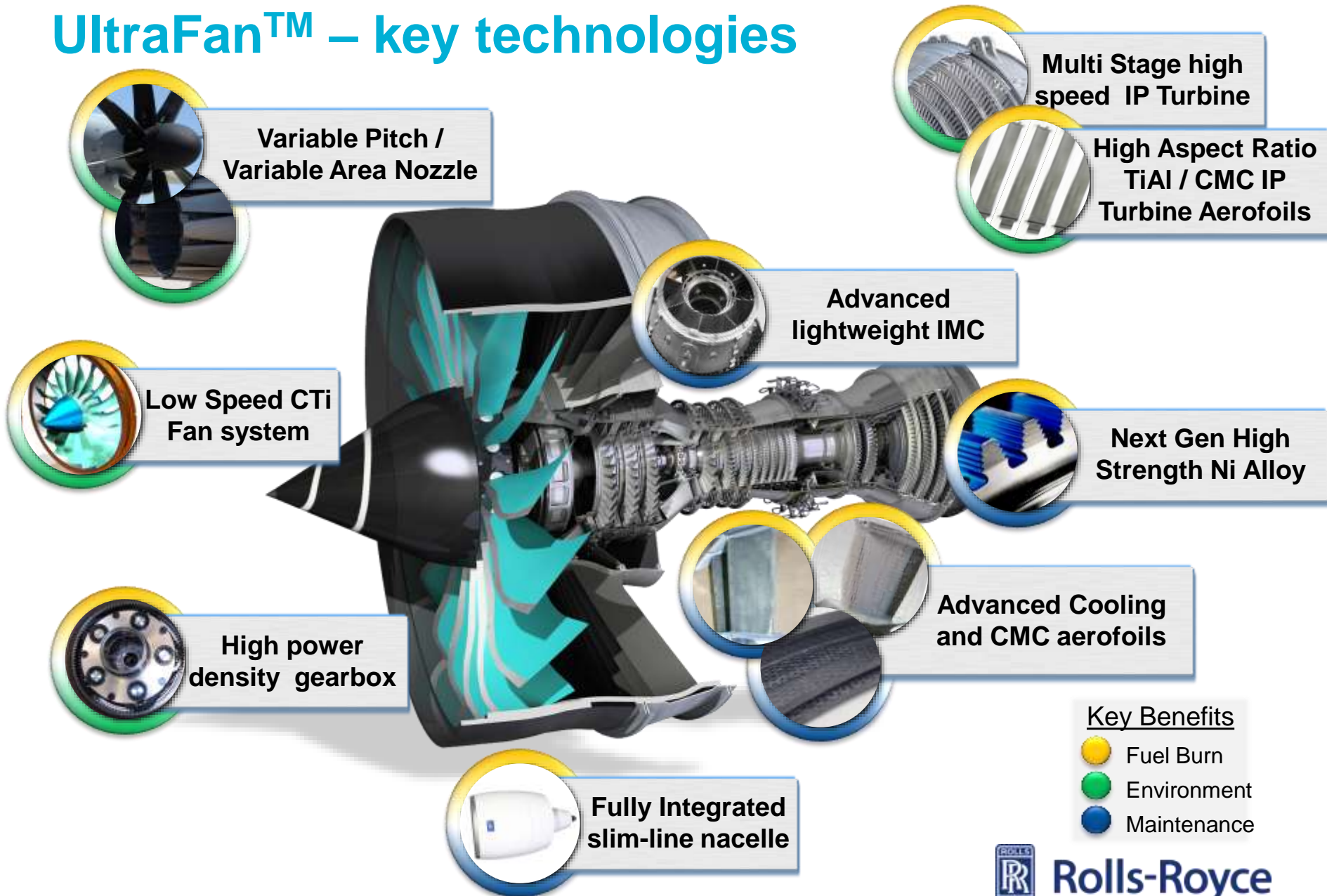


Technology programmes

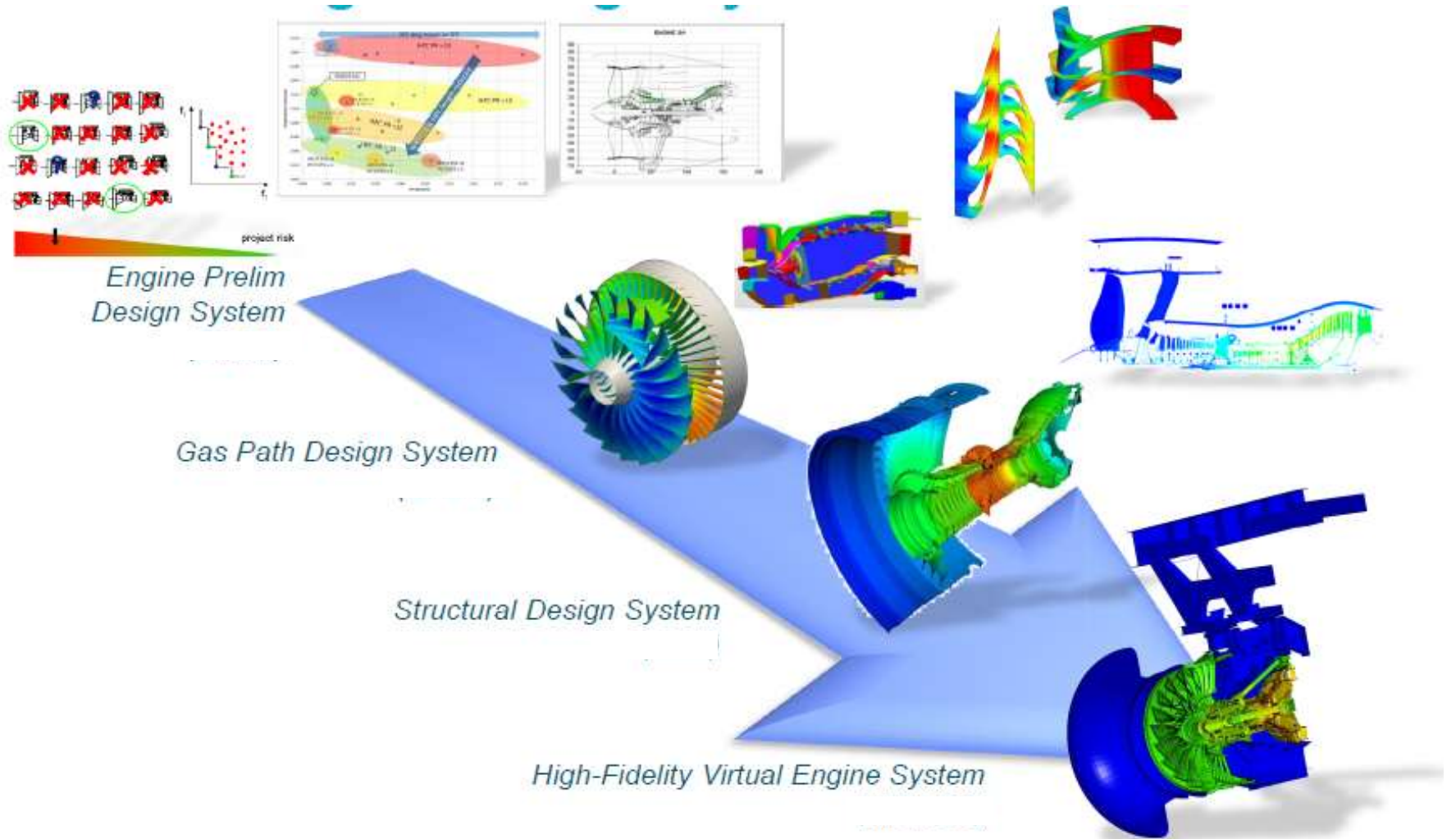
Architecture and design		Manufacture		Advanced materials		Intelligent systems		
Advance		Advanced manufacturing research centres		Advanced alloys	TiAl		Future systems	
Lean burn combustor		Additive Layer Manufacturing			Ni Alloys		Aerothermal excellence	
UltraFan		Specialist turbine manufacture		Ceramic Matrix Composites (CMCs)				
Virtual engine				Lightweight CTI fan system				
Small engine core technologies								
Small blisked fan								
						Advanced concepts (Vision 20)		

Underpinning our Vision strategy

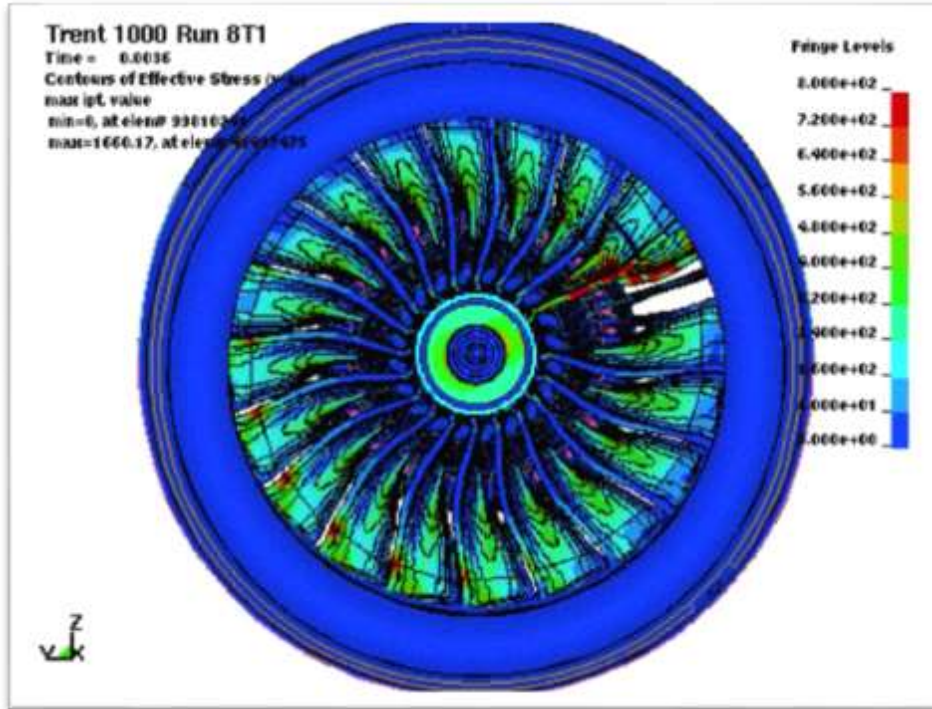
UltraFan™ – key technologies



The Backbone: An Agile Design Systems



The optimum validated design in application



Advanced manufacturing research centres



**Network of
Advanced Manufacturing
Research Centres AxRCs**



Comprehensive demonstration

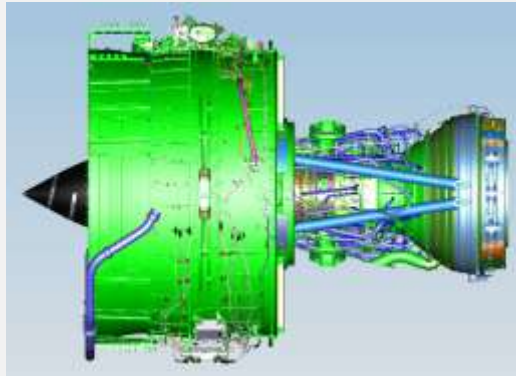


Proven maturity through multilevel demonstration

Full scale demonstration



ALPS



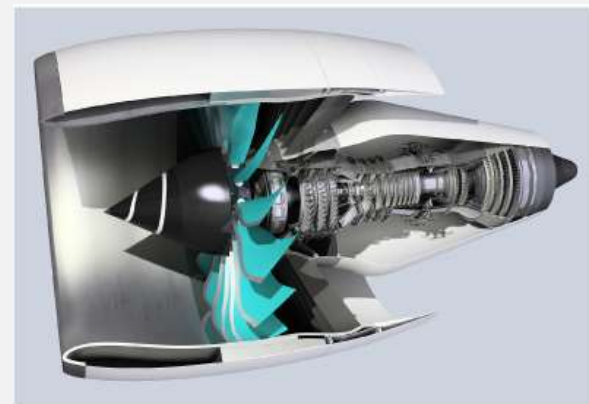
Advance



ALECSYS

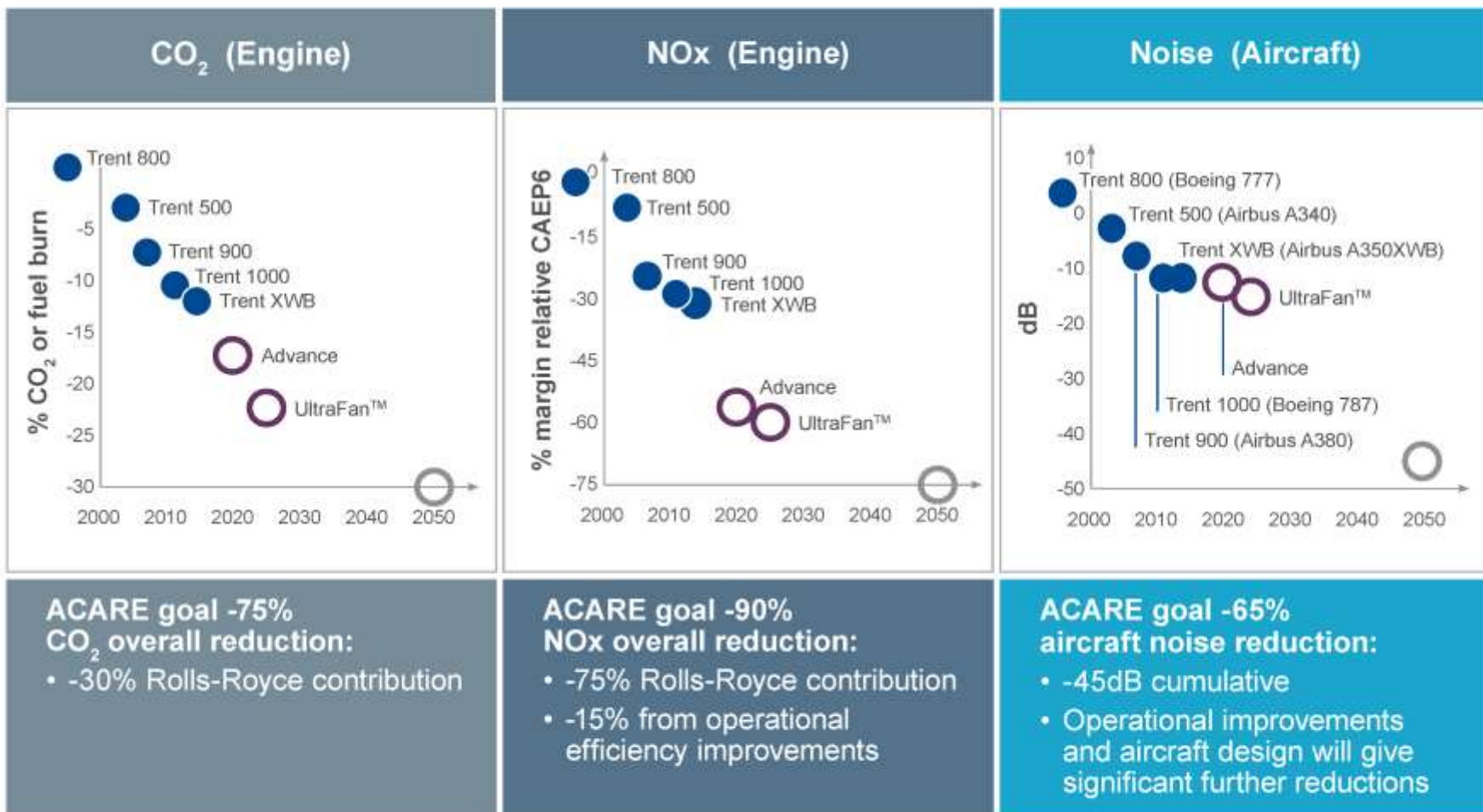


EFE & HT3



UltraFan

Getting us closer to our FP2050 goals



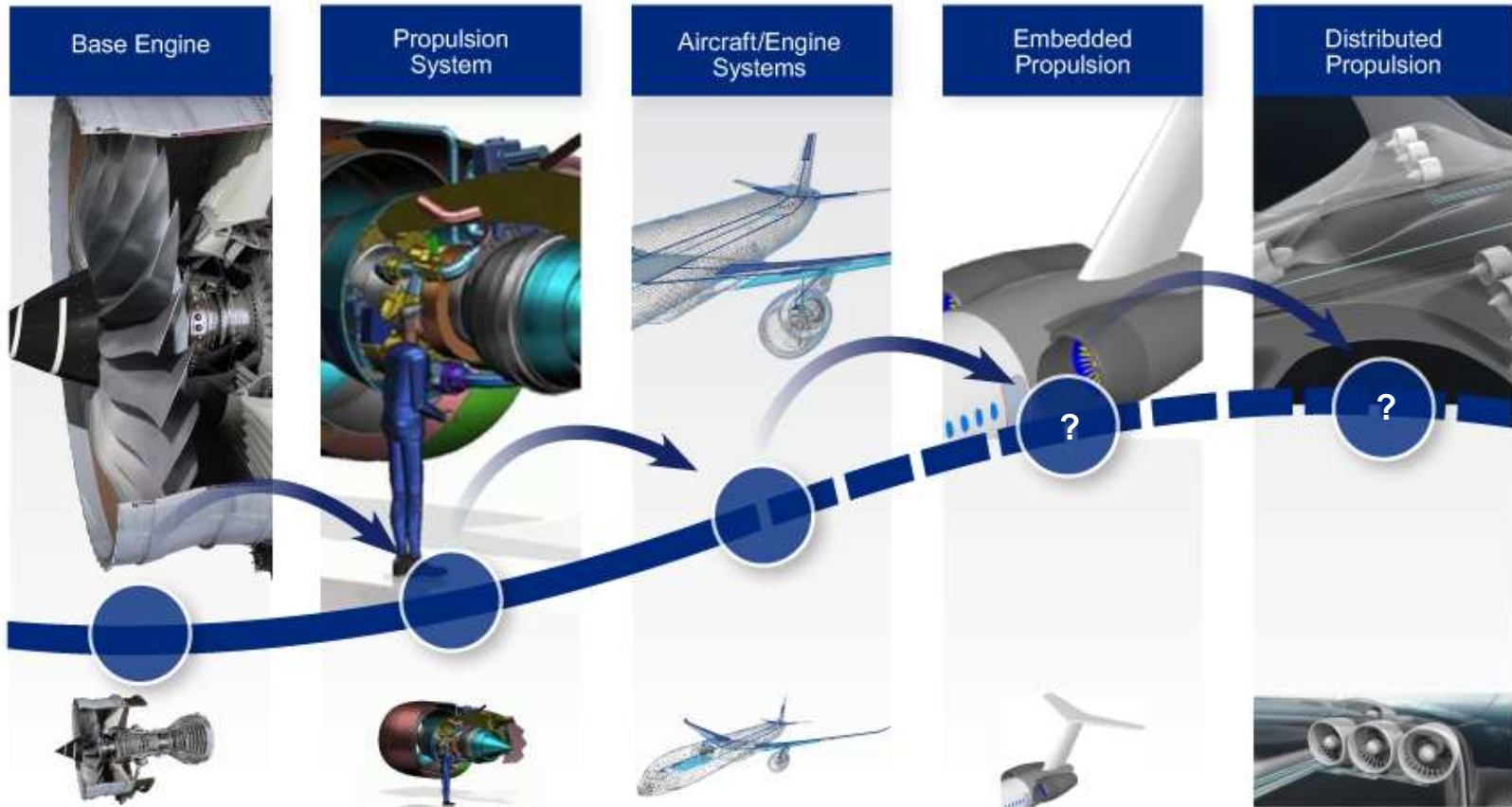
● Trent family
 ○ Technology demonstrator engine targets
 ○ ACARE (Advisory Council for Aviation Research and Innovation in Europe) Flightpath 2050 target

Vcom 16185

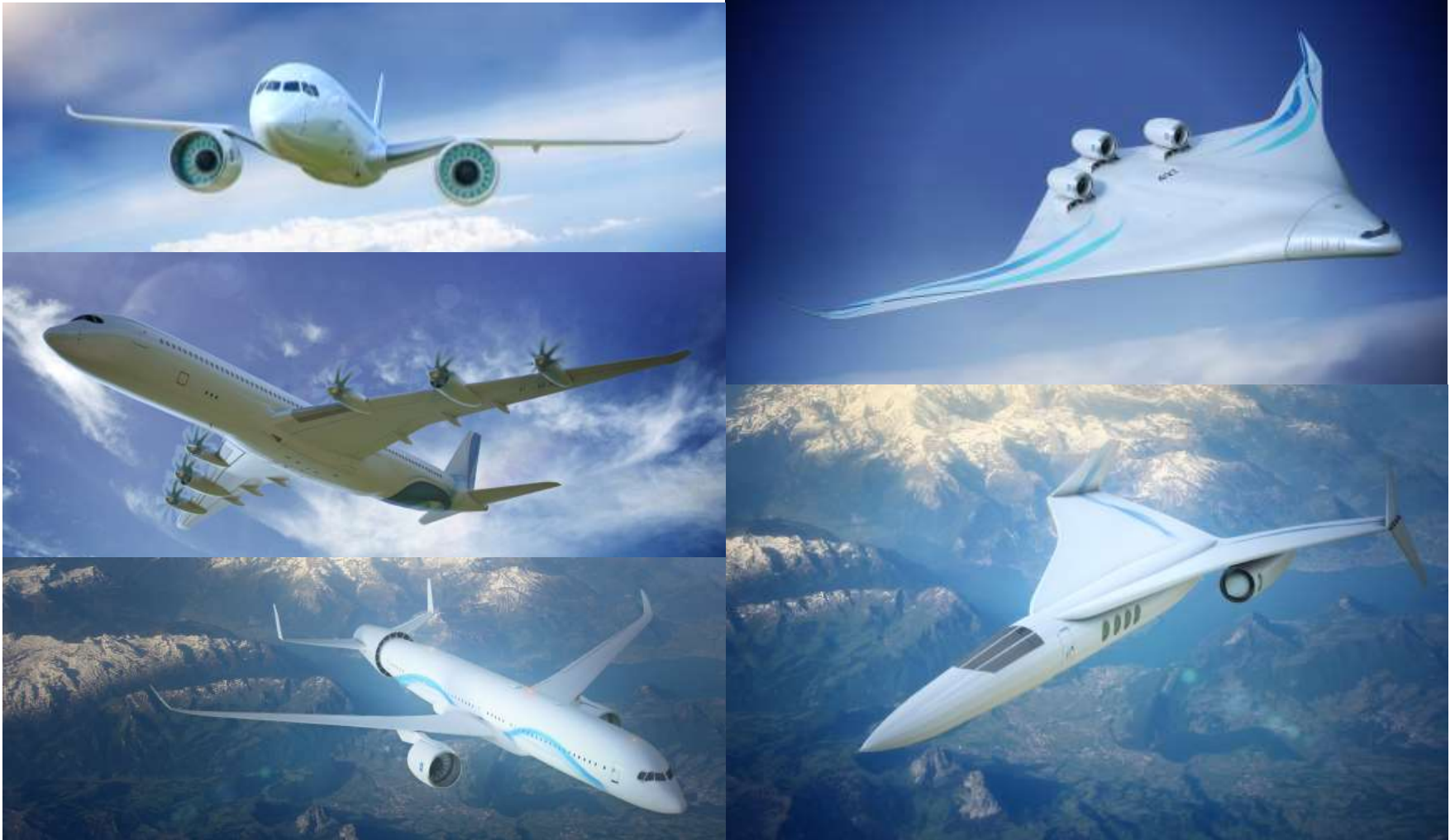
The longer term Future.....



Concept studies for Vision 20 and beyond



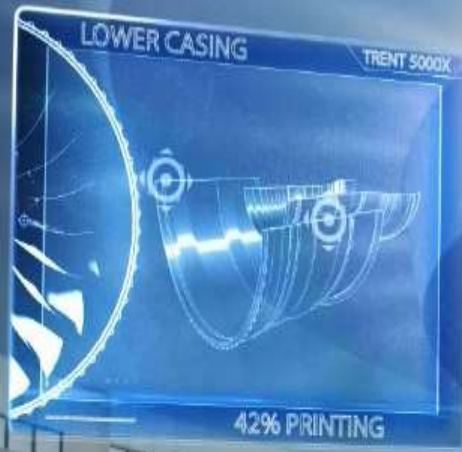
Vision 20 and beyond



Better power for a changing world



The Design/Make of Tomorrow



Rolls-Royce

ICAS, 26th September 2016



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Better power for a changing world