Co leadership by Rolls-Royce and Snecma

1 June 2006

Challenges facing Air Transport

- **Environment**
  - Global warming is a world-wide recognised issue
  - Europe has fixed clear targets to reduce negative impact
  - Global demand for oil will continue to rise leading to extremely volatile prices
  - Carbon trading is likely to increase

- **Economy**
  - Air Traffic is of significant importance for the enlarged European economy, global competitiveness, our way of living

Aeronautics is crucial to shape a future competitive and sustainable European economic growth

Green Engines Steering Committee Members

Initial list

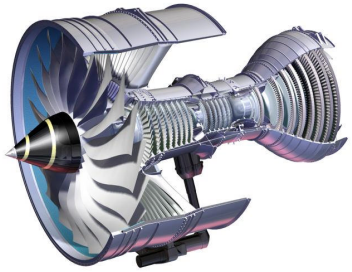
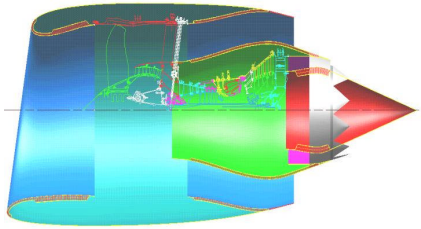
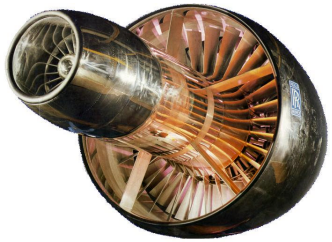
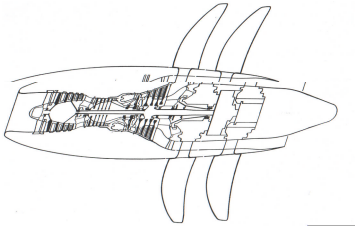
- Platform co-leaders: Rolls-Royce, Snecma
- Affiliates: RRD, Turbomeca, Hispano-Suiza, Aircelle, Techspace Aero
- Potential Associates: Avio, ITP, MTU, Volvo Aero,others?
- Members of JTI: Airbus, Eurocopter, Agusta, Alenia, Thales

Engine Demonstrators

- Scope: Design, Manufacture and Ground Test of Engines or HP Core
- Integrated Technology Demonstrators:
  - High BPR low weight technologies
  - High efficiency components
  - New power generation for more electric engines
  - New controls for smart engines
- Benefits
  - Reduction in Noise, Emissions, Fuel burn, Maintenance & System Complexity/Cost.
- Objectives
  - Design, build and test a number of demonstrator vehicles and rigs to validate the benefits of innovative,environmental technologies in a realistic operating environment
- Deliverables:
  - Proven Architecture for Advanced Engines
  - Mature “ready to use” technologies

Engines – Programme Phases Architecture

Test vehicles

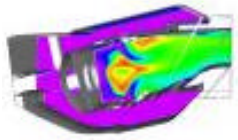





- **test vehicles** will be
  - selected from a range of options
  - depending on technology maturity and timing of market requirement in the following sectors:
    - Wide-body
    - Narrow-body
    - Regional
    - Helicopter

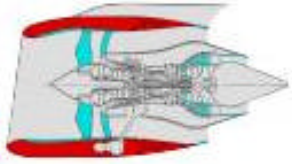
- **Options** include both:
  - Novel module technology within conventional architecture
  - Radical architecture change

Technologies

Emissions

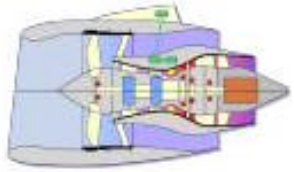


Noise

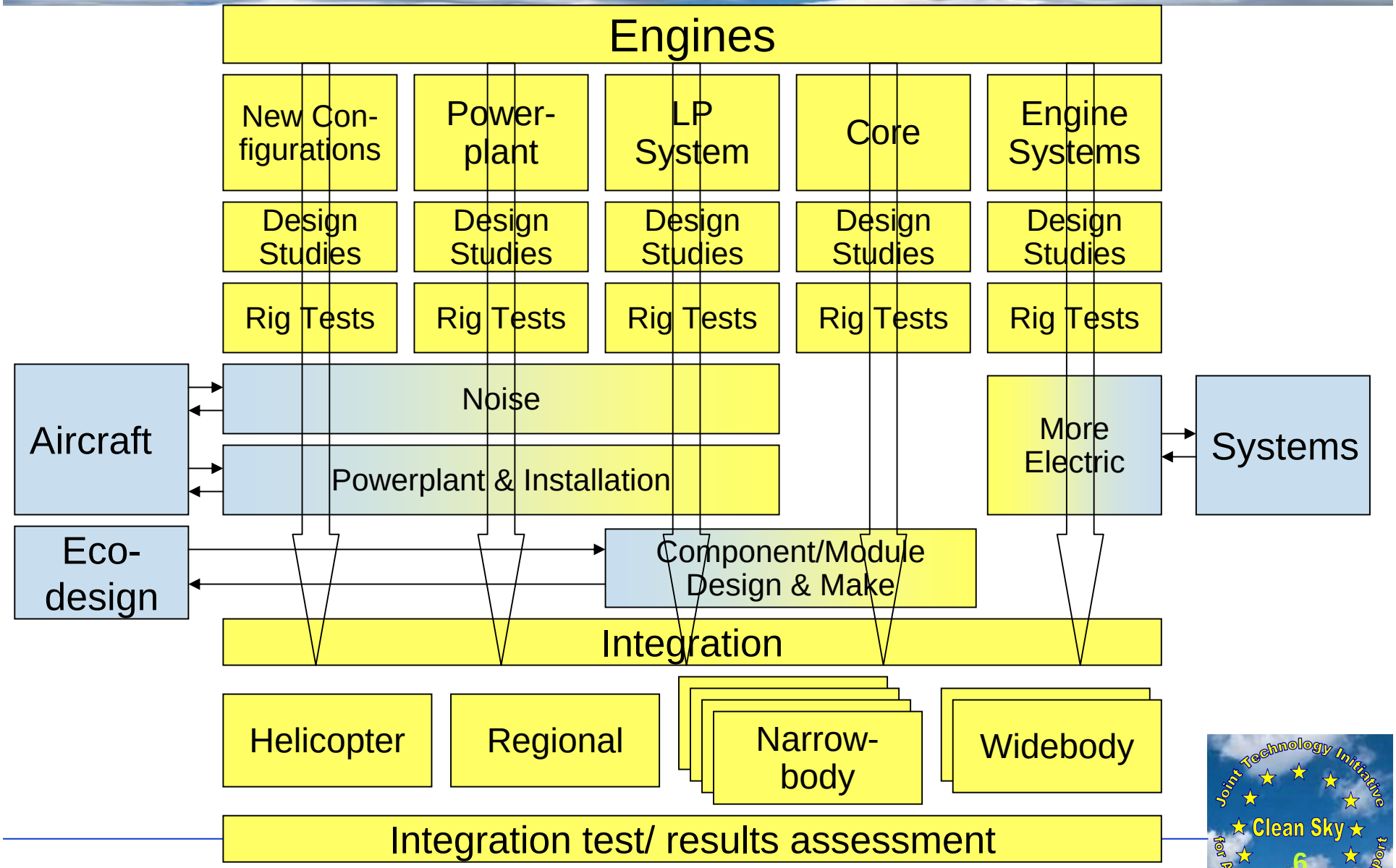


Weight

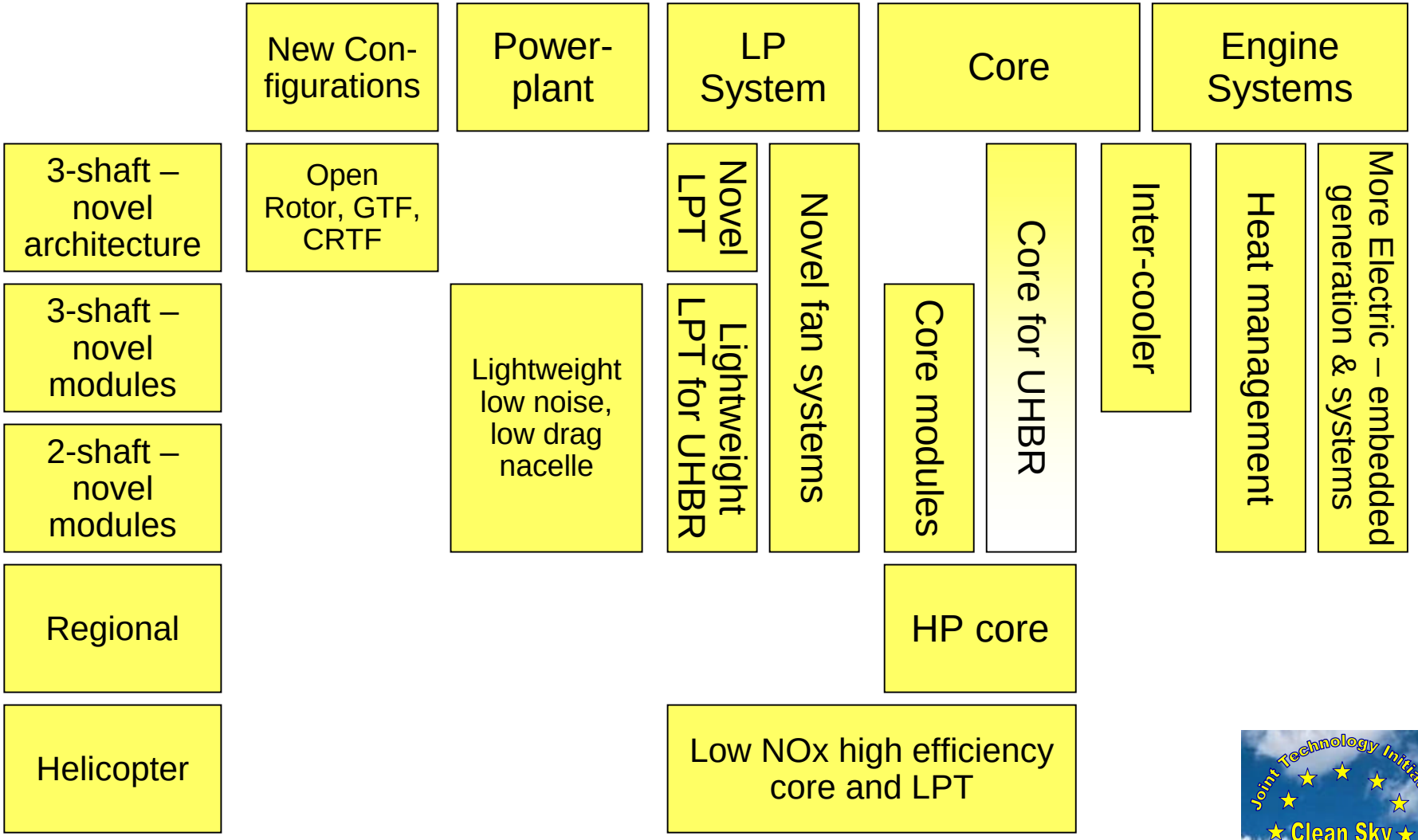
Electric



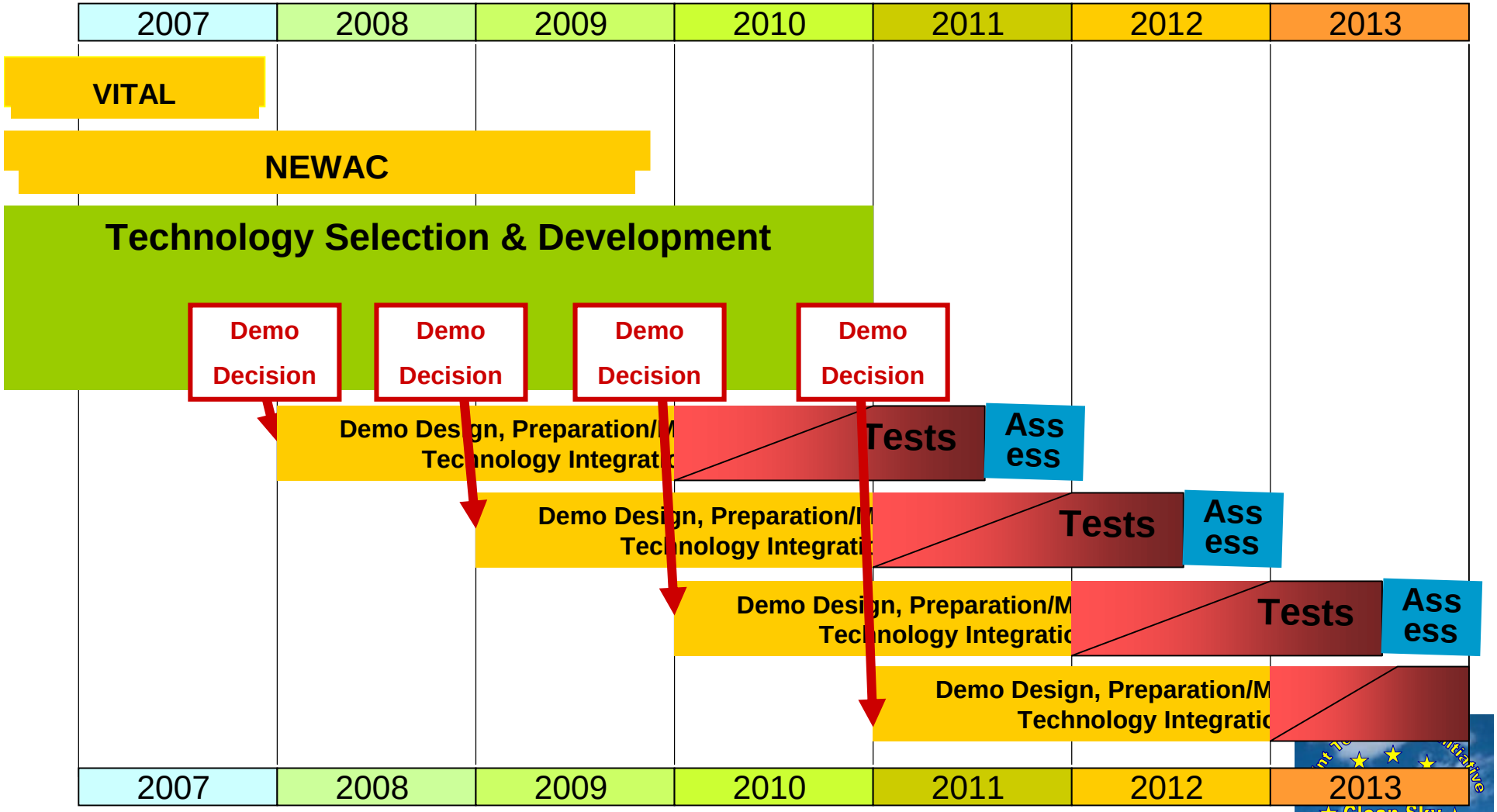
Engines – Integrated approach



Engines – Technologies and Integration Vehicles



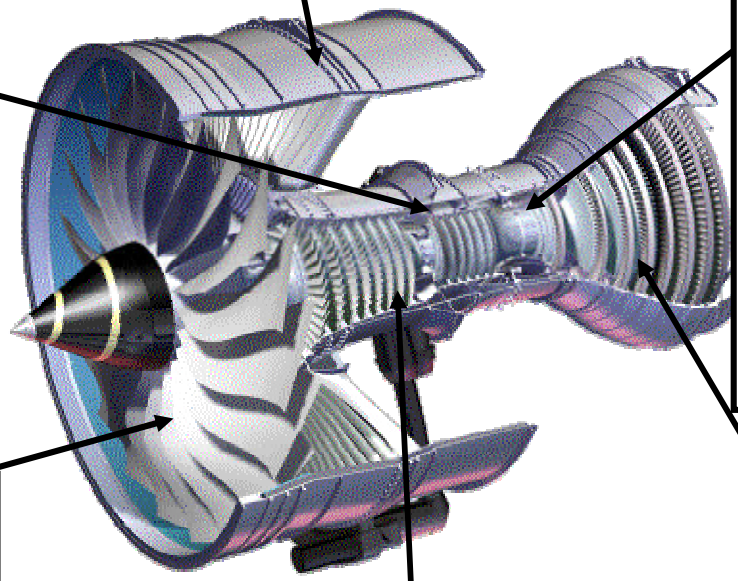
ENGINES – Plan



Novel Modules Engines (3- shaft)

Innovative powerplant – noise, drag, weight

Intercooler, cooled-cooling air and other heat management



Core suitable for ultra-high bypass ratio engines:
- Small
- High-speed
- Active
- High Temperature
- Lean-burn combustor

Technology from existing national programmes

Lightweight fan system suitable for ultra-high bypass ratio application

More-electric technology, including embedded (IP spool) generator, and power transfer technology

Large slow-speed LP system – LP turbine, structure and shafts

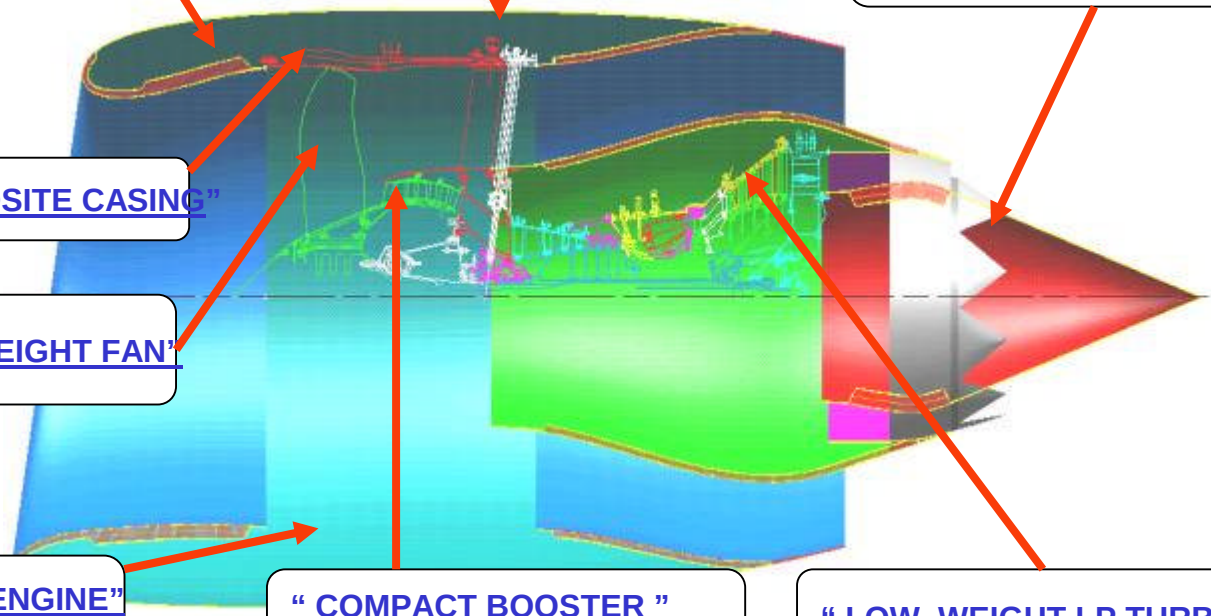
Novel Modules Engines (2- shaft)

“ IMPROVED ACOUSTIC DAMPING ”
post SILENCER technology liners

“ HYBRID LOW WEIGHT STRUCTURE”

“ DAMPING ATTACHEMENT”

“ LOW NOISE AND LIGHT EXHAUST”



“LOW WEIGHT COMPOSITE CASING”

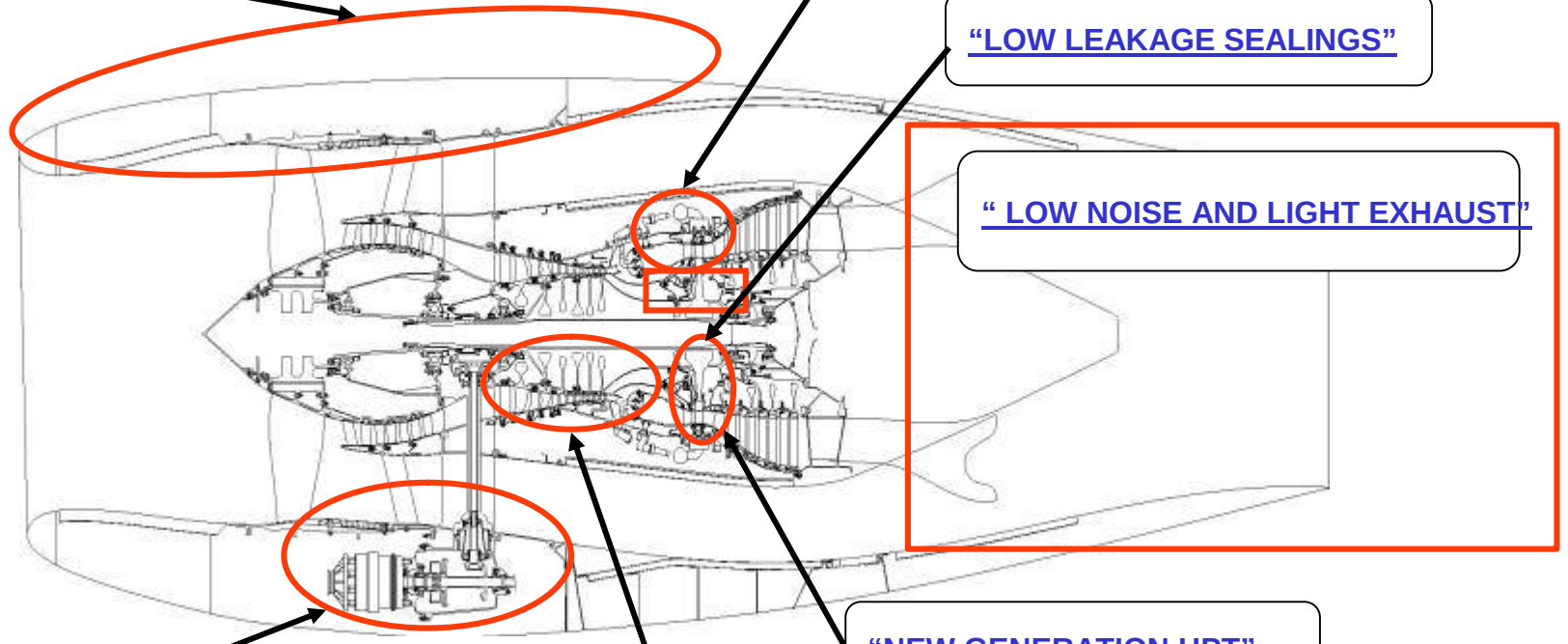
“ LOW NOISE / LOW WEIGHT FAN”

“ MORE ELECTRICAL ENGINE”
post POA-MOET technologies

“ COMPACT BOOSTER ”
VITAL technologies

“ LOW WEIGHT LP TURBINE ”

Novel Modules Regional Engines



“ IMPROVED ACOUSTIC DAMPING ”
post SILENCER technology liners

“CAEP6 – 60%” COMBUSTOR

“Alternative Fuel” COMBUSTOR

“LOW LEAKAGE SEALINGS”

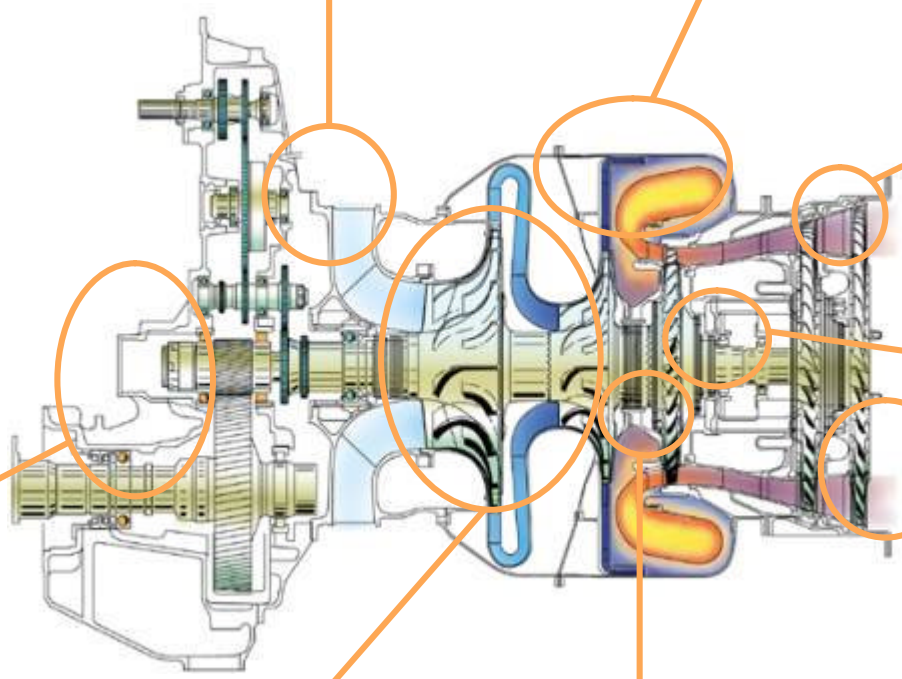
“ LOW NOISE AND LIGHT EXHAUST”

“NEW GENERATION HPT”

“ MORE ELECTRICAL ENGINE”
post POA-MOET technologies

“HIGH PERFORMANCE / LOW WEIGHT HPC”
NEWAC technologies

Novel Modules Helicopter Engines



Lower acoustic emission (air intake)

Low NOX combustor with LPP injectors NEWAC follow on

TiAl blades CMC containment ring

Inter-shaft bearing chamber

More electrical concept

New high pressure/flow 2 stages compressor NEWAC follow on

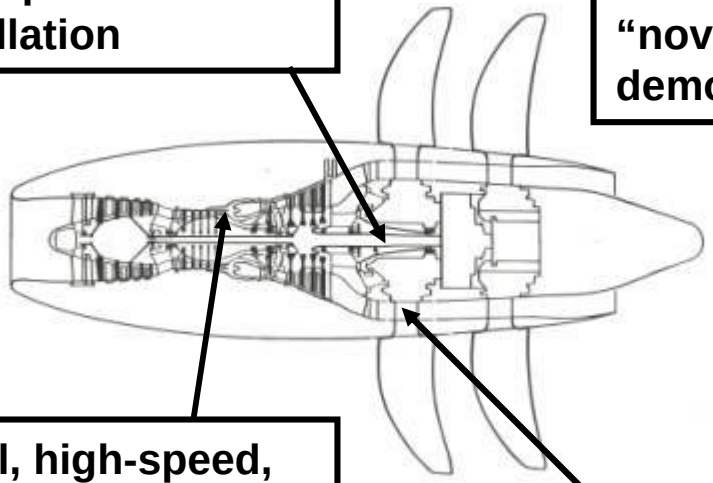
Cooled HP turbine CMC shroud

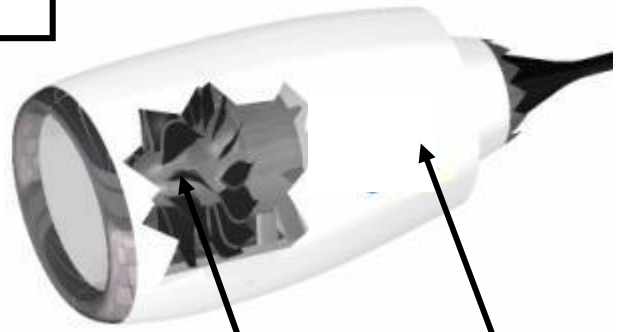
Lower acoustic emission (exhaust)

Radical New Architectures

"Clean-sheet" powerplant/ installation

Selection of module technologies as per "novel modules" demonstrators





Small, high-speed, high temperature core with lean-burn combustor

Architecture yet to be selected; joint airframe/engine platform decision:

- Open rotor
- Contra-rotor
- Geared turbofan

CONTRA FAN

CONTRA LP TURBINE