ENODISE 2nd Public Workshop with participation from DJINN and INVENTOR







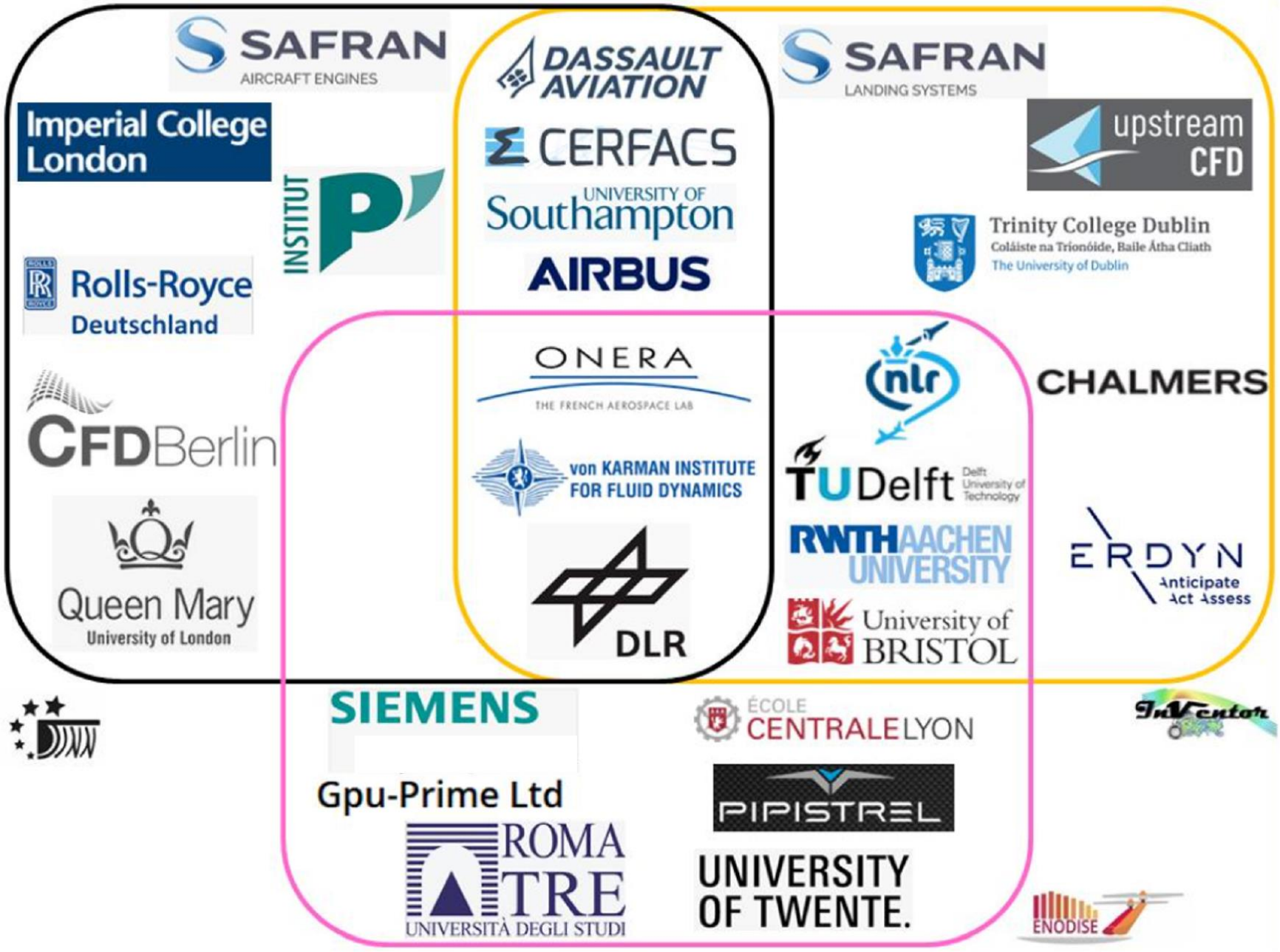
Advanced porous treatment, liners and metamaterials for engine and airframe noise mitigation

C. Schram (VKI)

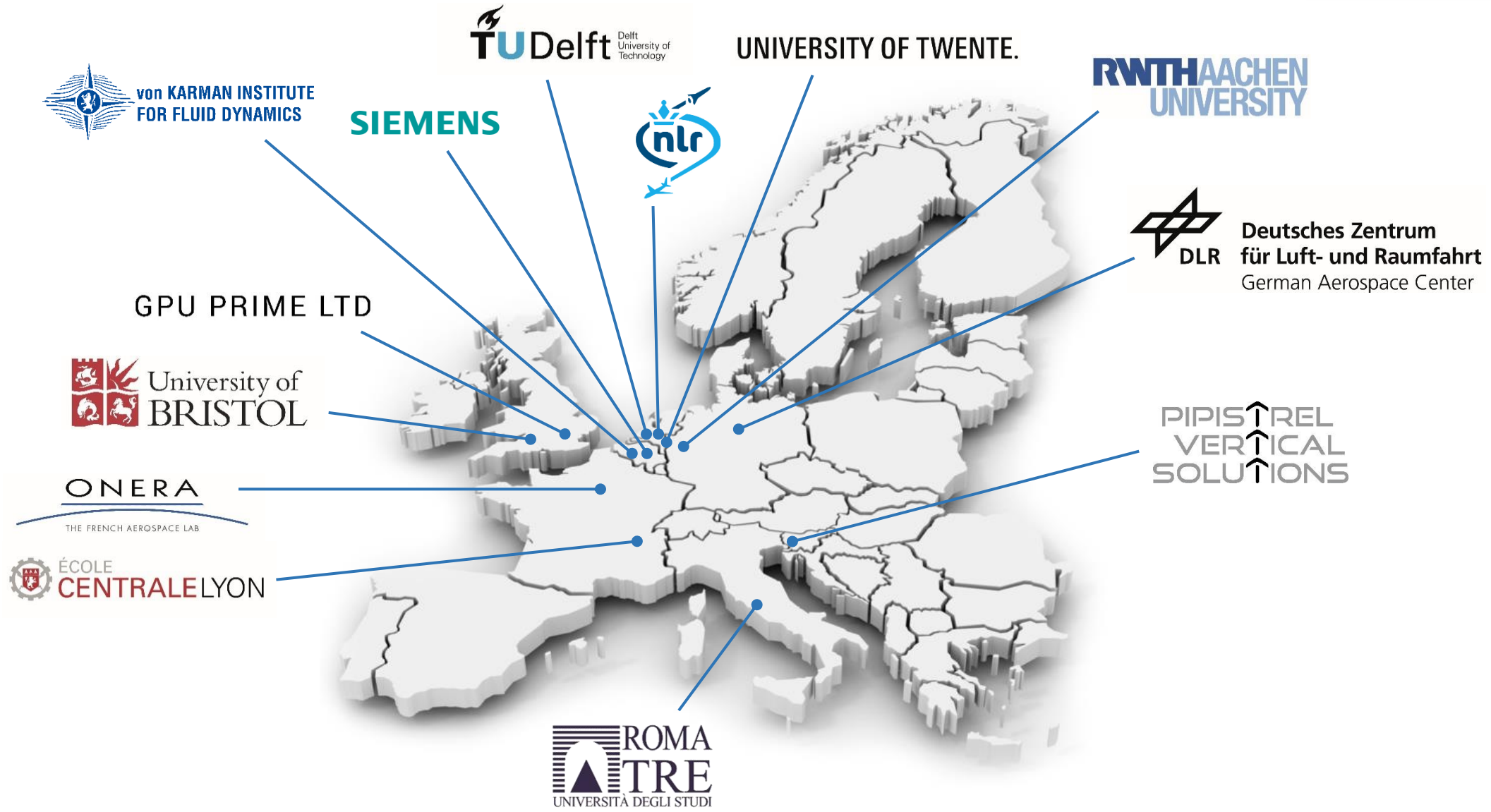
7 November 2022

ENabling Optimized DISruptivE airframe-propulsion integration concepts – GA 860103

Three companion projects for quieter aircraft



ENODISE consortium

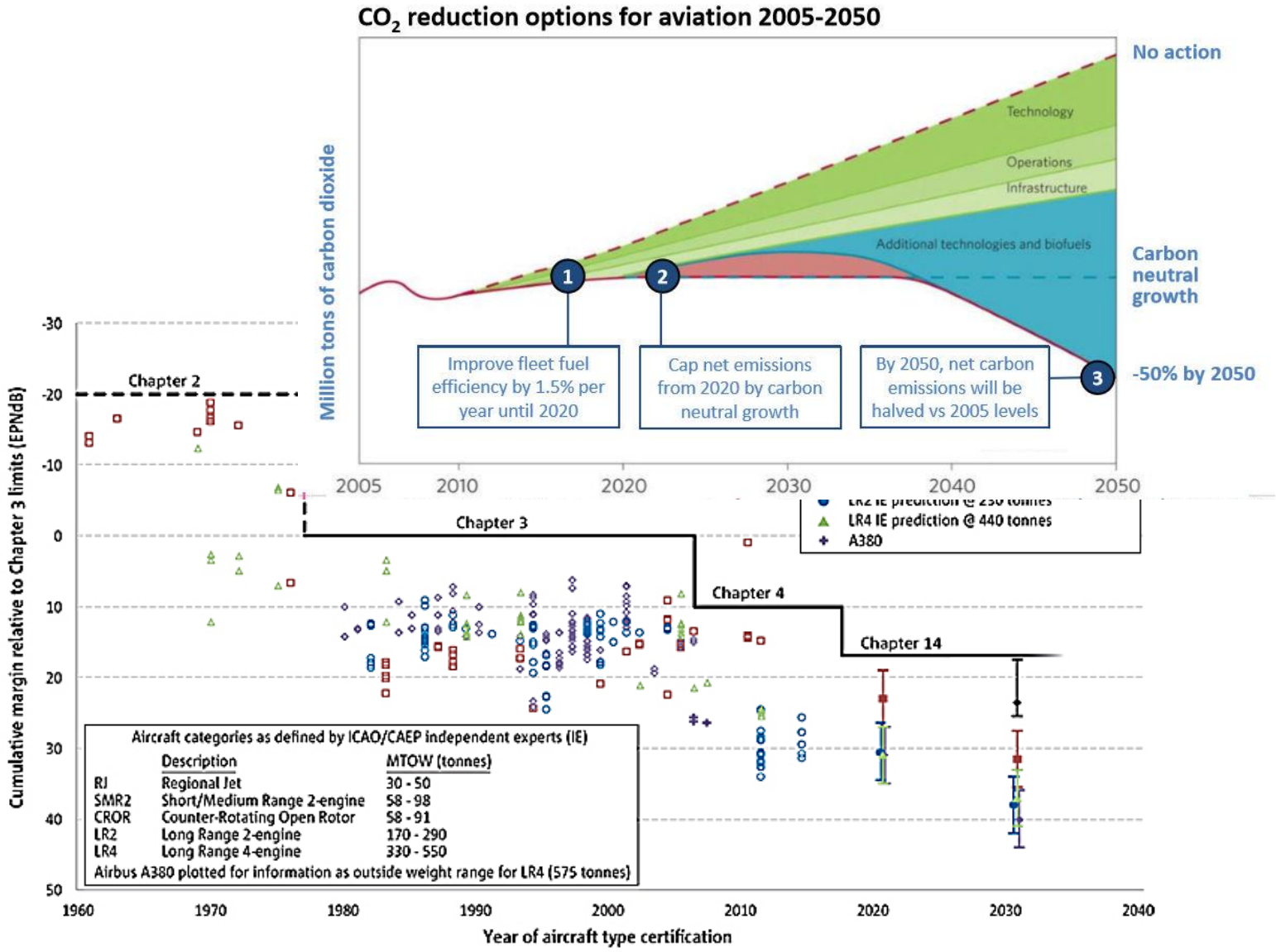


Long-term objectives

- Flightpath 2050 objectives
  - improved mobility
  - protecting the environment
  - ensure EU technological lead

→ need for radically new concepts

- ENODISE: novel propulsion-airframe integration concepts



Commercial transport aircraft — **Disruptive aircraft concepts** — *Urban Air Mobility*

Fixed-wing

Buried conventional engines
NASA N2B [1]
Aurora D8 [2]
ONERA NOVA [3]



Electric engines
Airbus eFanX [4]



Distributed Electric Propulsion

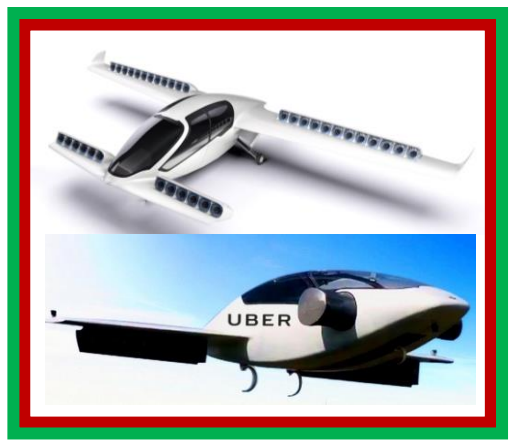
Airframe-integrated & ducted

Fixed
Airbus E-Thrust [7]



Boundary Layer Ingestion (BLI)

Vectorial thrust
Lilium [5], *Uber Elevate* [6]



Pylon

Multi-copter

Tilt rotor
Uber Elevate [7]



Fixed
Airbus RACER [9]
Opener BlackFly [10]



Fixed Counter- or co-rotating rotors
Ehang184 [8]
CityAirbus [11]
Uber Elevate [7]



Propeller-airframe potential/viscous interactions

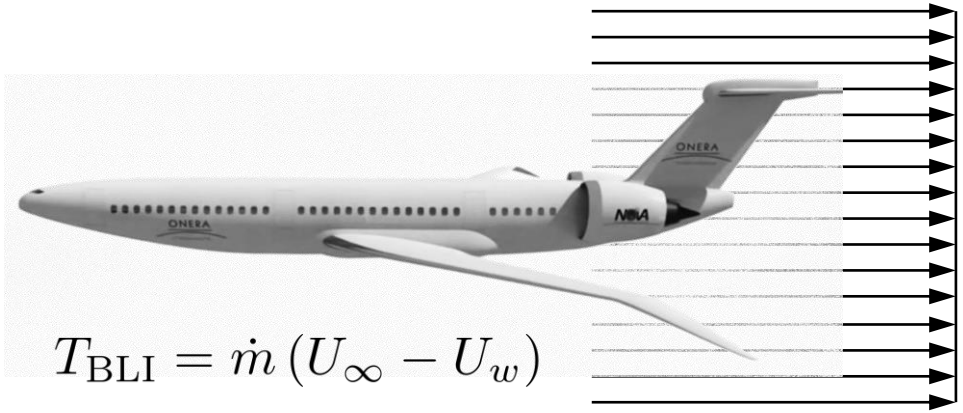
Opportunities and challenges

Boundary Layer Ingestion



$$T_{\text{conv}} = \dot{m}\,(U_j - U_\infty)$$

$$P_{\text{lost,conv}} = \frac{\dot{m}}{2}\left(U_j^2 - U_\infty^2\right)$$



$$T_{\text{BLI}} = \dot{m}\,(U_\infty - U_w)$$

$$P_{\text{lost,BLI}} = \frac{\dot{m}}{2}\left(U_\infty^2 - U_w^2\right)$$

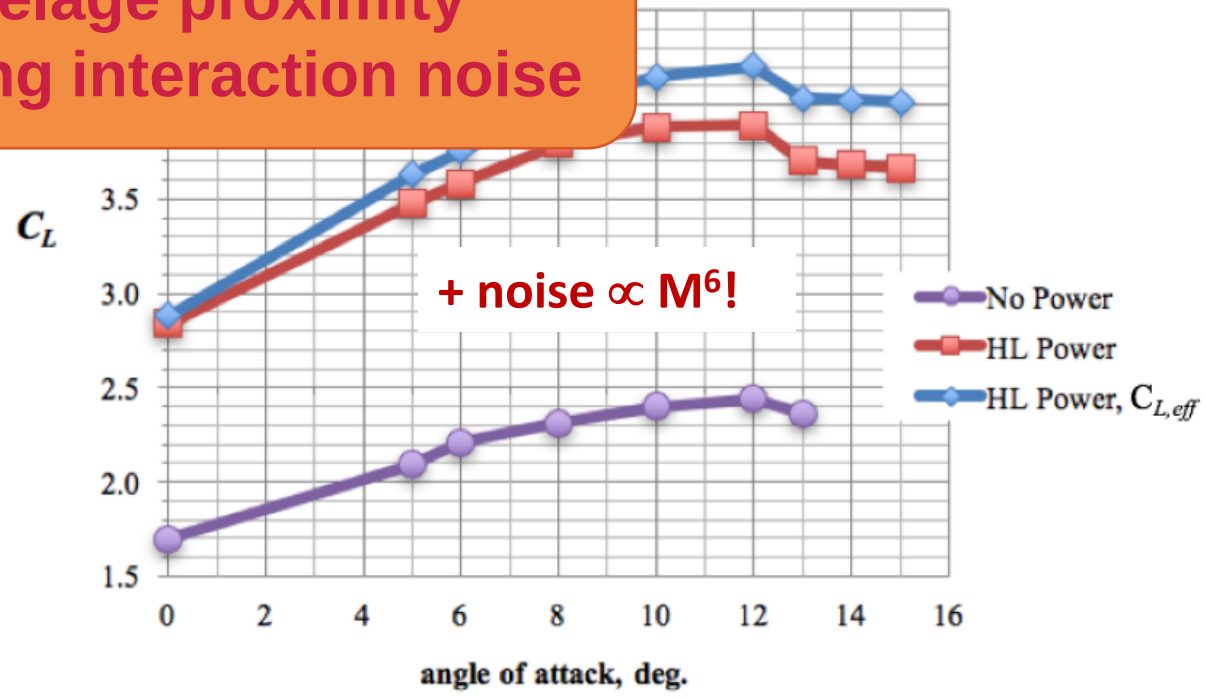
+ noise shielding!

☹ inflow distortion due to the developing boundary layer / fuselage proximity

☹ propeller wake – wing interaction noise

Distributed Electric Propulsion





+ noise ∝ M⁶!

A low-to-mid TRL enabler project

ENODISE aims at providing the required knowledge and methods to enable the development of a next generation of aircraft concepts

1. Better understand the beneficial and detrimental airframe-propulsion interactions
   - aero-propulsive efficiency (→ pollutant emissions)
   - noise generation and scattering

   → extensive experimental databases with fine parameter variations
2. Assess the current numerical capabilities to simulate and optimize these interactions
   → cross-validation with experimental database
3. Evaluate the potential of flow and noise control strategies to further enhance the aero-propulsive benefits by mitigating the adverse interactions

3 generic configurations for 3 kinds of integration problems

- BLI

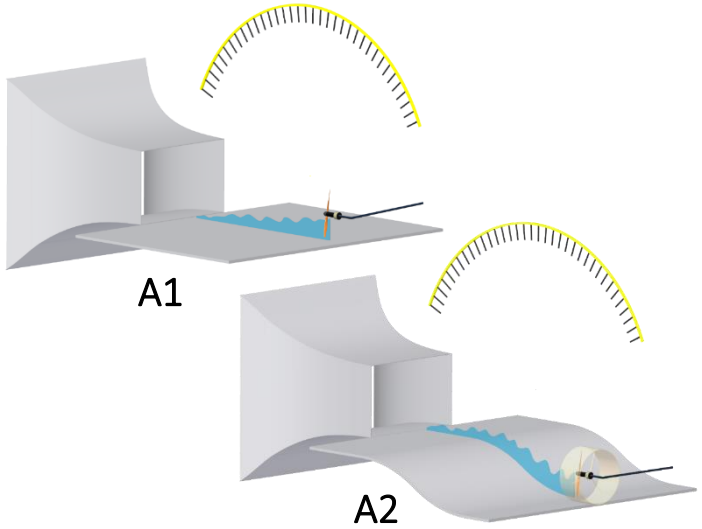


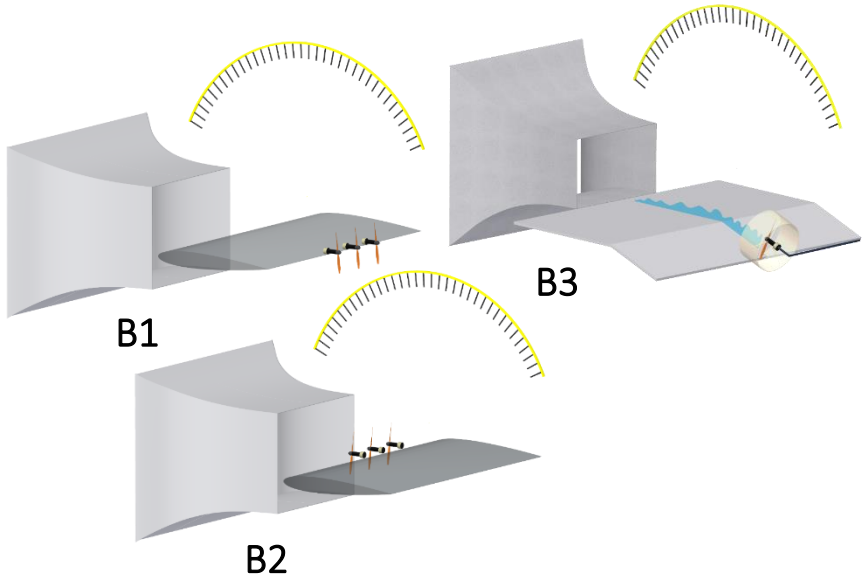
- DEP

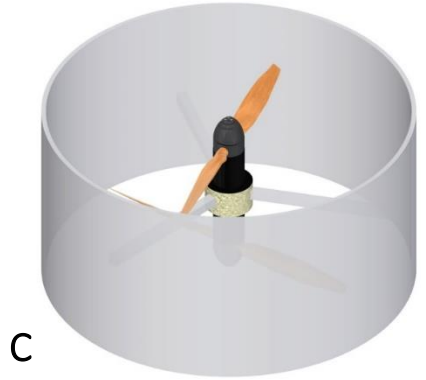


- Tandem rotors

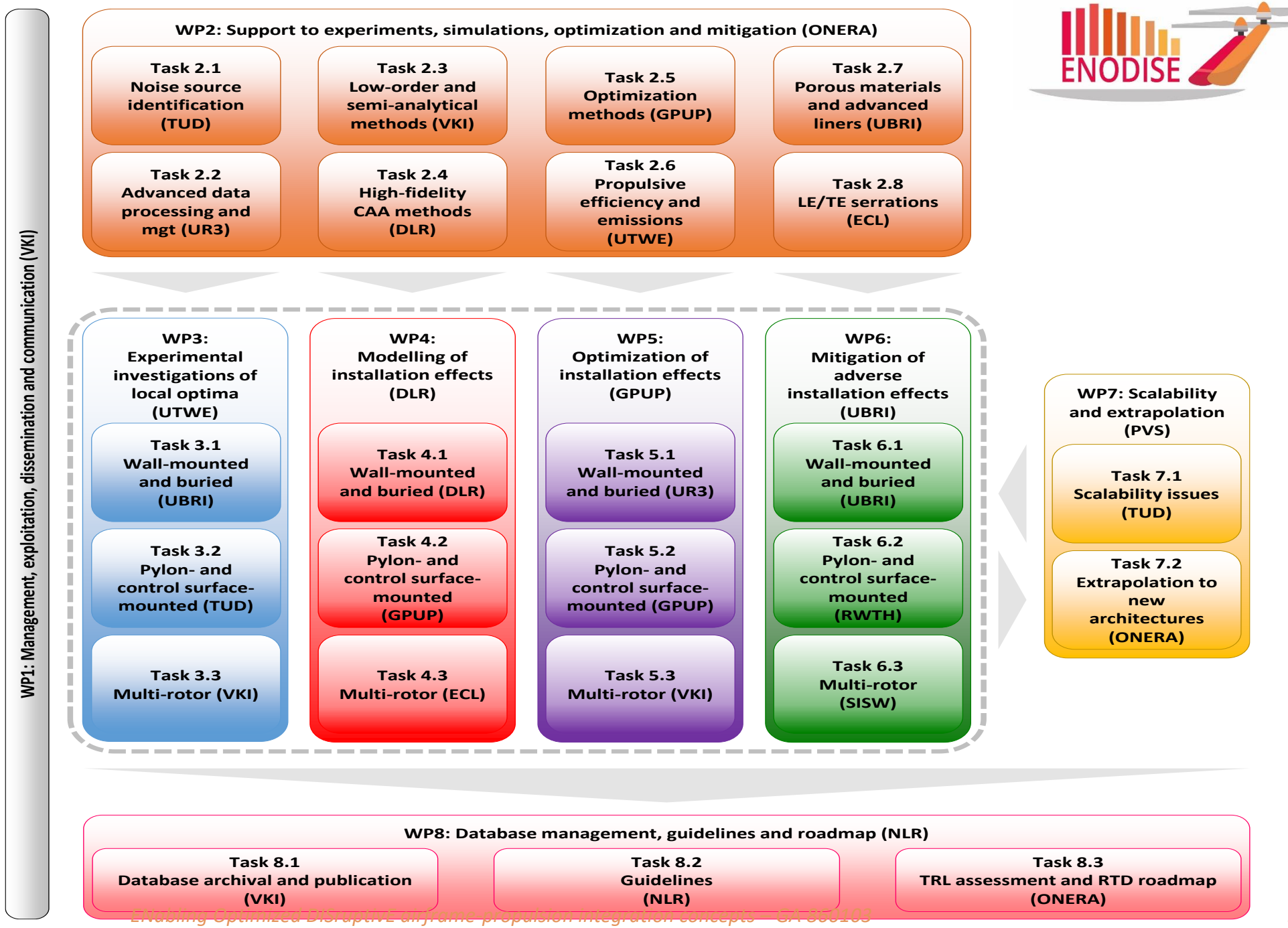








Work Breakdown Structure



Key deliverables

- WP2 – Support to experiments, modelling and simulations
  - Upgraded experimental techniques and modelling tools
- WP3 – Experimental investigation of local optima
  - Aero-propulsive vs. noise trade-offs
  - Documented experimental datasets
- WP4 – Modelling of installation effects
  - Benchmarking numerical tools
  - Documented numerical datasets
- WP5 – Optimization of installation effects
  - Validated multi-objective design methodology

Key deliverables

- WP6 – Mitigation of adverse installation effects
  - Potential of existing and future flow/noise control technologies for future aircraft concepts
  - Related experimental and numerical datasets
- WP7 – Applicability to disruptive concepts
  - Extrapolation of the laboratory-scale outcomes towards full-scale novel aircraft concepts
- WP8 – Database generation and management, conclusions and guidelines
  - Cleaned and documented databases posted on public repositories
  - Complete set of guidelines (experiments, simulations, best design practices, noise mitigation, data archival, …)
  - White paper incl. executive summary on future aircraft concepts

Thanks for your attention



Questions ?