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Future Energy, Propulsion Operational Challenges – Opportunities for a Disruptive Approach

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Air Transport

A major contributor to global social & economic prosperity

- Over 2.6 billion passengers & 48 million tonnes of freight per year, worldwide
- Support nearly 8% of the world's economy
- 19th rank in size by GDP* if aviation were a country (similar to Switzerland)
- Global economic impact: // $ 2.2 trillion (direct, indirect, induced & tourism catalytic)
  // 3.5% of world GDP
- 1,500 airlines
- 23,800 commercial aircraft in service
- 3,850 commercial airports

A major global employer

- 8.4 million direct jobs
- 56.6 million jobs globally

*GDP: Gross Domestic Product
Abstract from ATAG report – March 2012

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Airbus: A Global Company

100 % EADS company

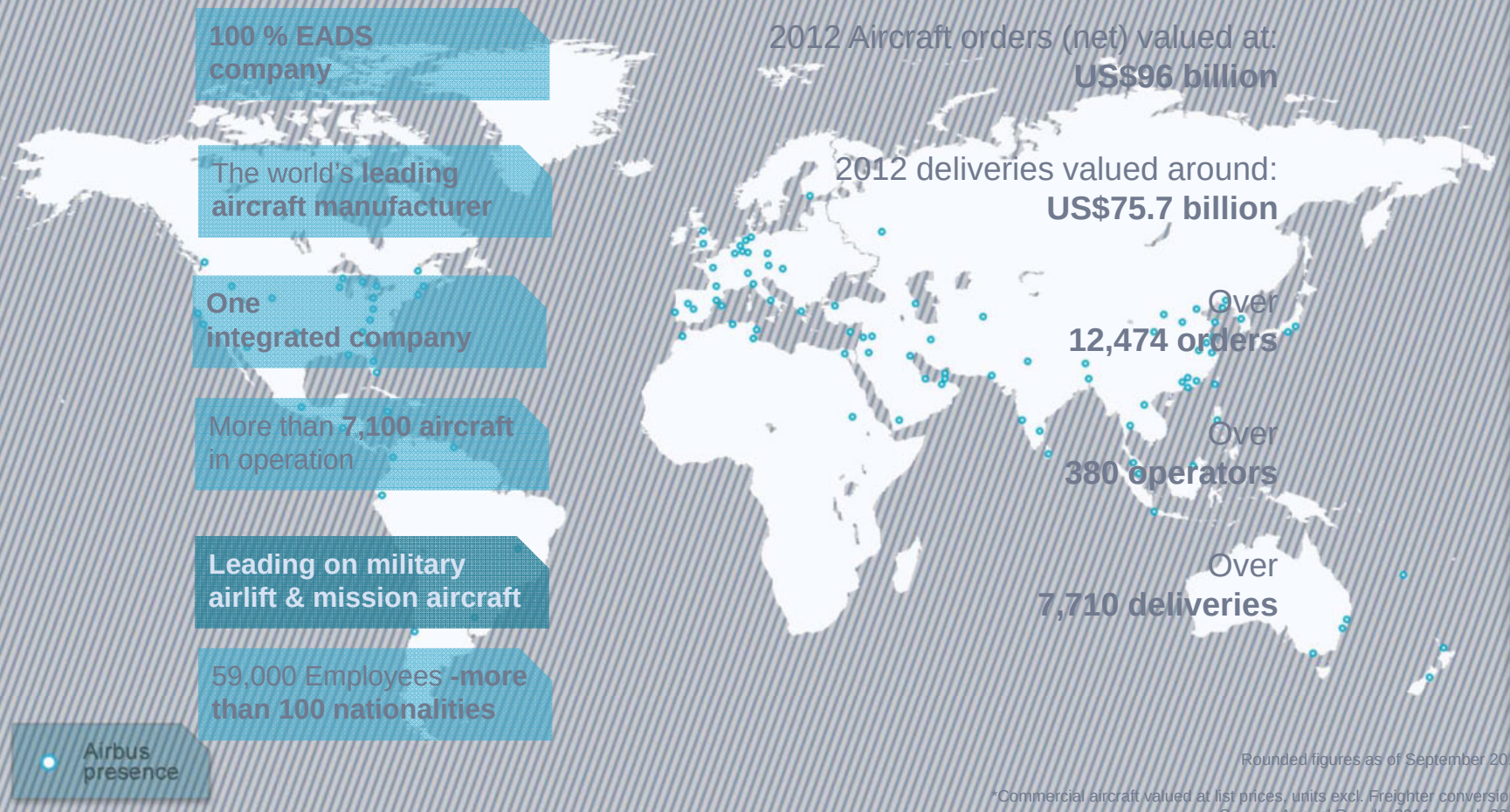
The world's **leading aircraft manufacturer**

One integrated company

More than **7,100 aircraft** in operation

Leading on military airlift & mission aircraft

59,000 Employees **-more than 100 nationalities**



2012 Aircraft orders (net) valued at:
US$96 billion

2012 deliveries valued around:
US$75.7 billion

Over
12,474 orders

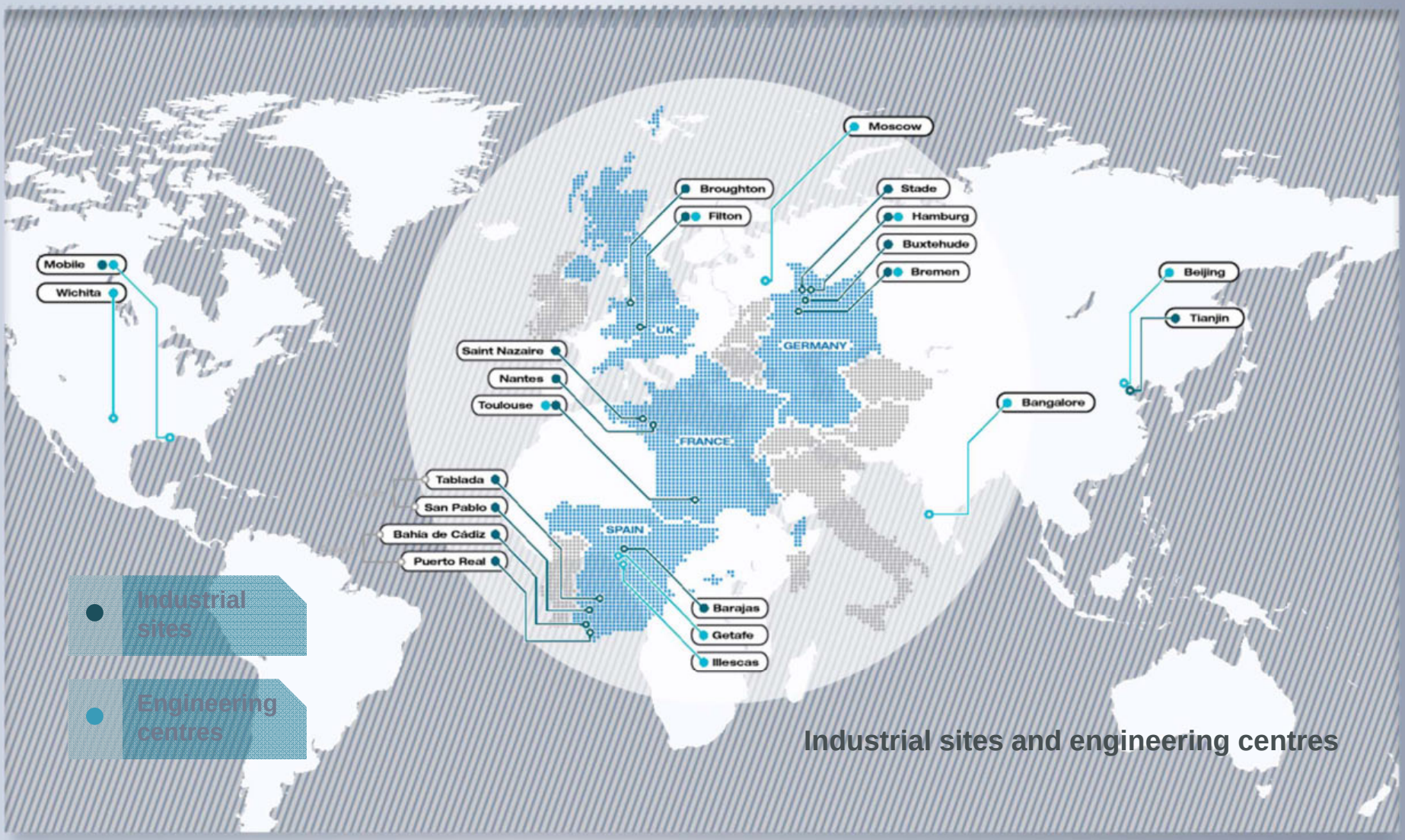
Over
380 operators

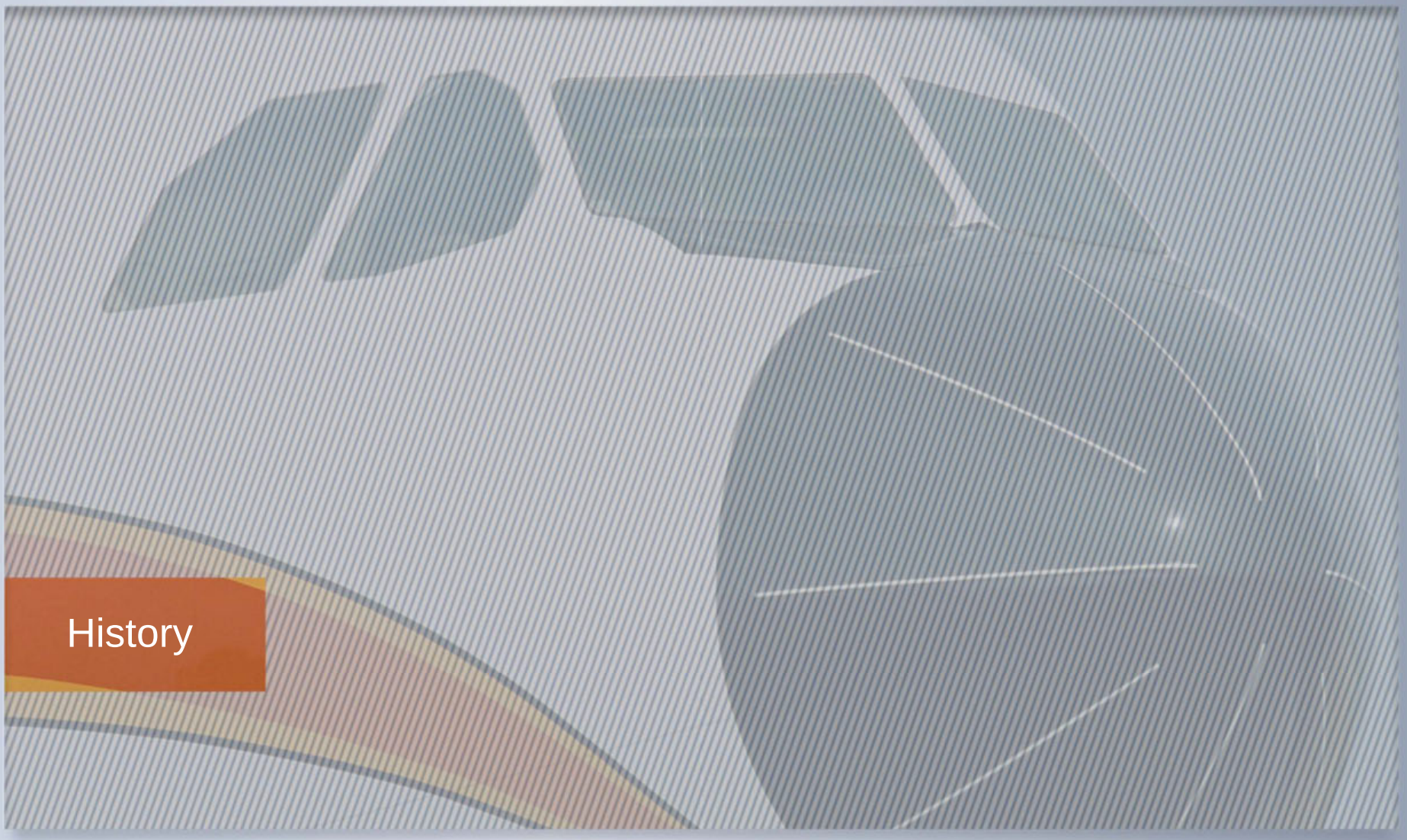
Over
7,710 deliveries

Rounded figures as of September 2012

*Commercial aircraft valued at list prices, units excl. Freighter conversions
Source: Annual Results 2011, march 2012

Airbus Today





History

History

Putting Europe back on the civil aviation scene

1967
French, German and British governments agreement on the development of an European aircraft

1970
Creation of **Airbus Industrie GIE**
(Grouping of Economic Interest)

1972
A300 first flight
World's first twin-aisle twin-engine widebody aircraft

1982
A310 first flight
Two men cockpit

1983
A300-600 first flight
A modern version of A300

1987
A320 first flight
A new family, the widest single aisle cabin
First fly-by-wire flight controls & side stick controllers

1991
A340 first flight
Four engines, long-haul aircraft

1992
A330 first flight
Two engines, long-haul aircraft

1993
1,000th aircraft Delivery
A321 first flight
Expanding the A320 family

1994
A300-600ST first flight

1995
A319 first flight
Expanding the A320 family

History

The world leading aircraft manufacturer

2001
Airbus integrated company

A340-600 first flight

2002
3,000th aircraft delivery

A318 first flight
Expanding the A320 family
A340-500 first flight

2004
5,000th aircraft order

2005
A380 first flight

2006
A350XWB
Industrial launch
(Extra wide-body)

2007
5,000th aircraft delivery

First Chinese production facility in Tianjin

2009
A400M first flight

2010
6,000th aircraft delivery

A320neo
Industrial launch
new engines option

2011
10,000th aircraft order

7,000th aircraft delivery

2012
Final assembly of the first A350XWB

First-ever commercial "Perfect flight" with an A319 – cutting CO_2 emissions by more than 40%

First U.S. production facility in Mobile, Alabama

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Airbus Family

A full range of market leading civil airliners

- **A320 family:**
  A take-off or landing every 2.5 seconds,
  Over 7 billion passengers carried since EIS in 1988

- **A330 family:**
  A take-off or landing every 25 seconds,
  More than 800 A330s sold since 787 launch

- **A350 XWB:**
  First Flight mid 2013
  617 firm orders from 35 customers

- **A380:**
  Takes-off or lands approx. every 6.5 minutes
  125 flights per day and 1.5 million pax per month

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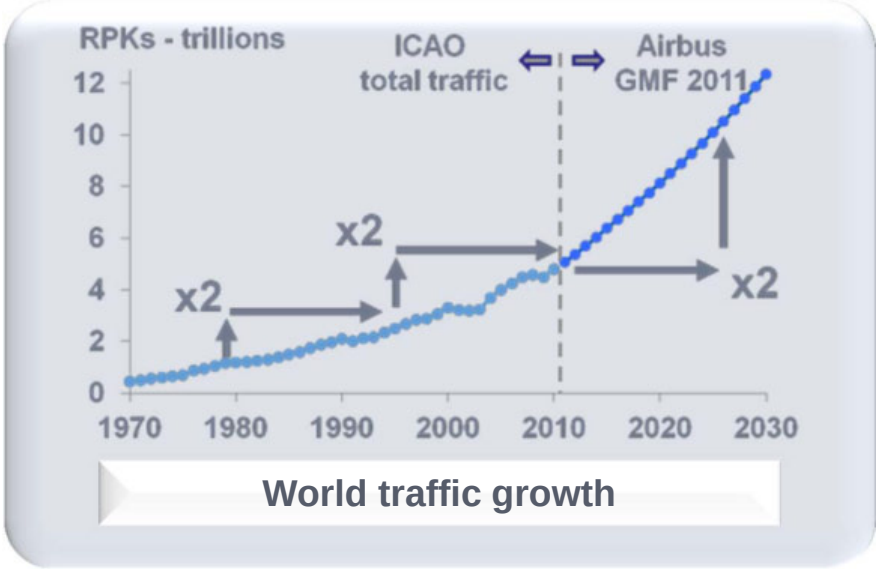
Innovation

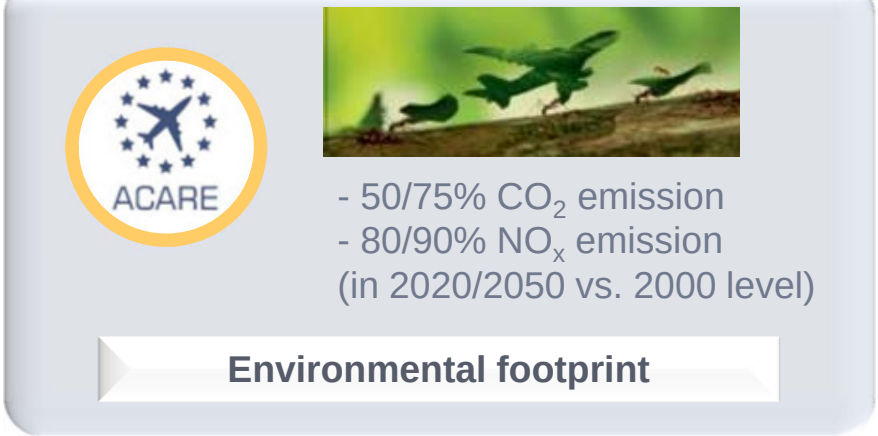
40 years of innovation, a driver for success

- **A300B:**
  First ever widebody twin-engine in the 70s forward-facing crew cockpits in the 80s
- **A320 Family:**
  Side-stick & electronic engine controllers
  Digital auto flight system
  Aerodynamic improvements (winglets, sharklets)
- **A380:**
  Unprecedented fuel efficiency and comfort
- **A350 XWB:** a game changer
  over 53% of composite material
- **Environment:**
  First aircraft manufacturer awarded ISO 14001 - all sites and products

Challenges for the aviation industry



World traffic growth



Environmental footprint

Tremendous challenges for aviation !

Competition
Ex.: Short/Medium Range A/C

Technological Leavers on Fuel consumption 1

- **Innovative System**
  - All systems topics as enablers for game-changing a/c configuration
  - Compatibility with novel propulsion (and fuels) proposals
  - Systems weight reduction items (e.g. hydraulic-less aircraft)
  - Operation

- **Smart wing technologies**
  - Natural Laminar Flow
  - Hybrid Laminar Flow
  - Surface technologies
  - Flow control

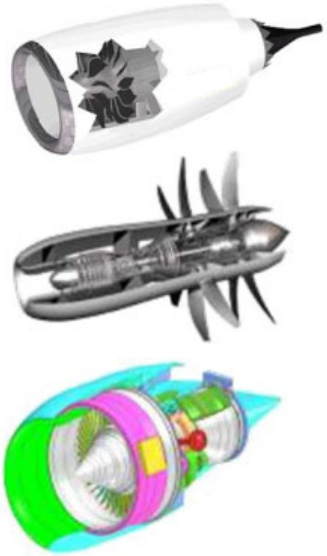
Breguet equation

$$SR = \frac{a}{W * g} * \frac{M * L/D}{SFC}$$

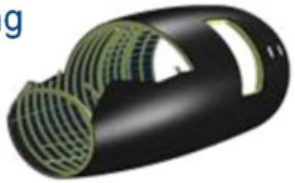
Technological Leavers on Fuel consumption 2

- **Weight savings though load management**
  - Active and passive load control

- **Innovative Powerplant**
  - Open Rotor configuration
  - Geared Turbo Fan
  - Advanced Turbo Fan
  - Energy harvesting



- **Innovative Structures**
  - New materials, composite, advanced alloys, multifunctionnal
  - Structural health monitoring
  - Nano technologies



Breguet equation

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Overall integration and potential impact on configuration is a key success factor
Operation optimisation will be also a key factor

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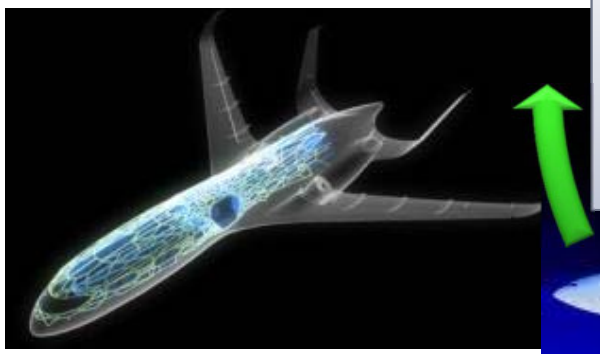
Overall configuration challenge



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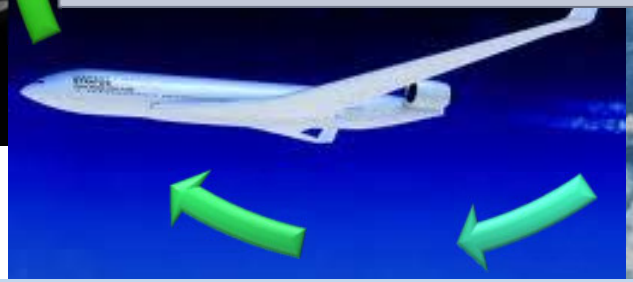

Need to shift from single discipline asymptotic trend... thanks to capabilities and skills enabling multipoint and multidisciplinary configuration optimisation

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Former European Aircraft Concept Research: NACRE (2005-2010)

- Started in April 2005, lasted 5 years
- Budget € 30m, € 16.9m funded by EC
- 4 major aircraft manufacturers, 3 major engine manufacturers, 3 key suppliers, 10 Research Centres, 7 Universities, 4 SMEs

Champion concepts were nurtured within NACRE, aiming at, respectively:

- Increased Environmental performance
- Improved Passenger experience
- Low-Cost high-Volume

The Proactive Green

The Passenger Experience

The Simple Flying Bus

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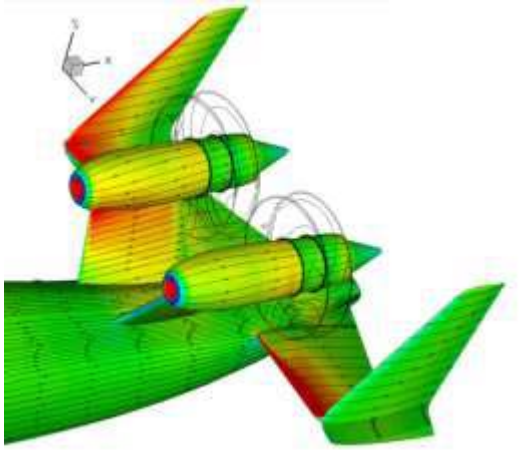
NACRE Results

Multidisciplinary Design and Analysis Capabilities for Components

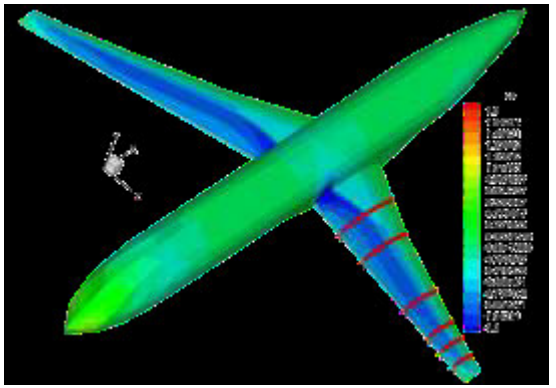
- Open Rotor propulsion systems & integration
- Powered Tail innovative integrated design & analysis
- Natural Laminar Flow wing design & transition prediction
- Flying Wing configuration design and multidiscplinary assessment



Experimental Validation & Testing Techniques

- Rear-engine integration (Aerodynamics & Noise)
- High-Energy Absorption
- Flying Wing cabin evacuation
- Innovative Evaluation Platform development

NACRE
New Aircraft Concepts Research
NACRE



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From NACRE to PROCON2030

NACRE resulted in the capability to design

- environmental driven aircraft
- passenger experience driven aircraft
- cost-efficient aircraft

NACRE results were taken up in the CleanSky1 program

PROCON2030

New Aircraft propulsion concepts, configuration integration & operations for 2030+

The new project PROCON should extend the capabilities, meeting the challenge

- Energy change
- Climate change
- Operations change

An additional capability will be the robustness of solutions in different scenarios

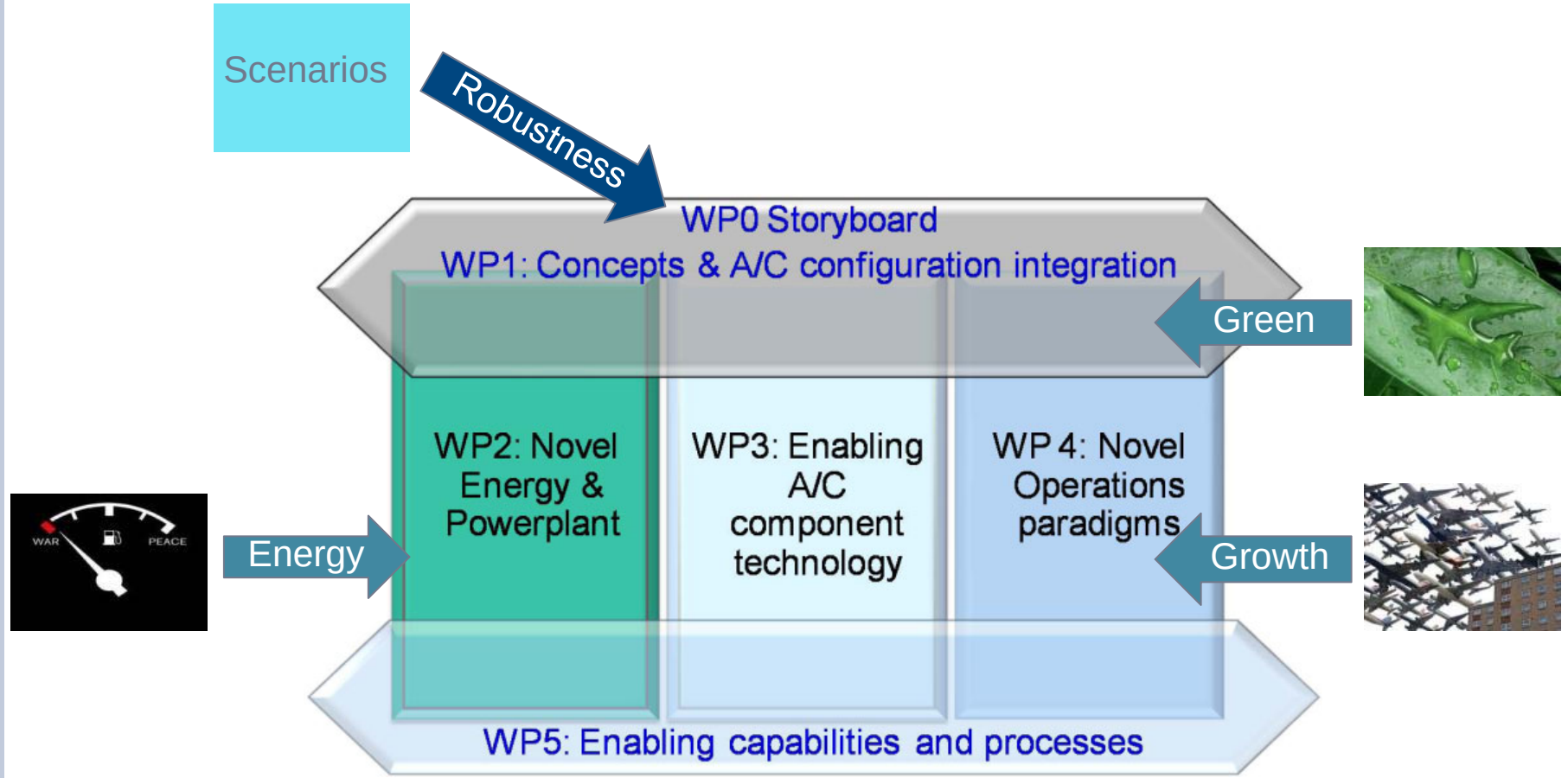
PROCON results will feed in the CleanSky2 program

Energy

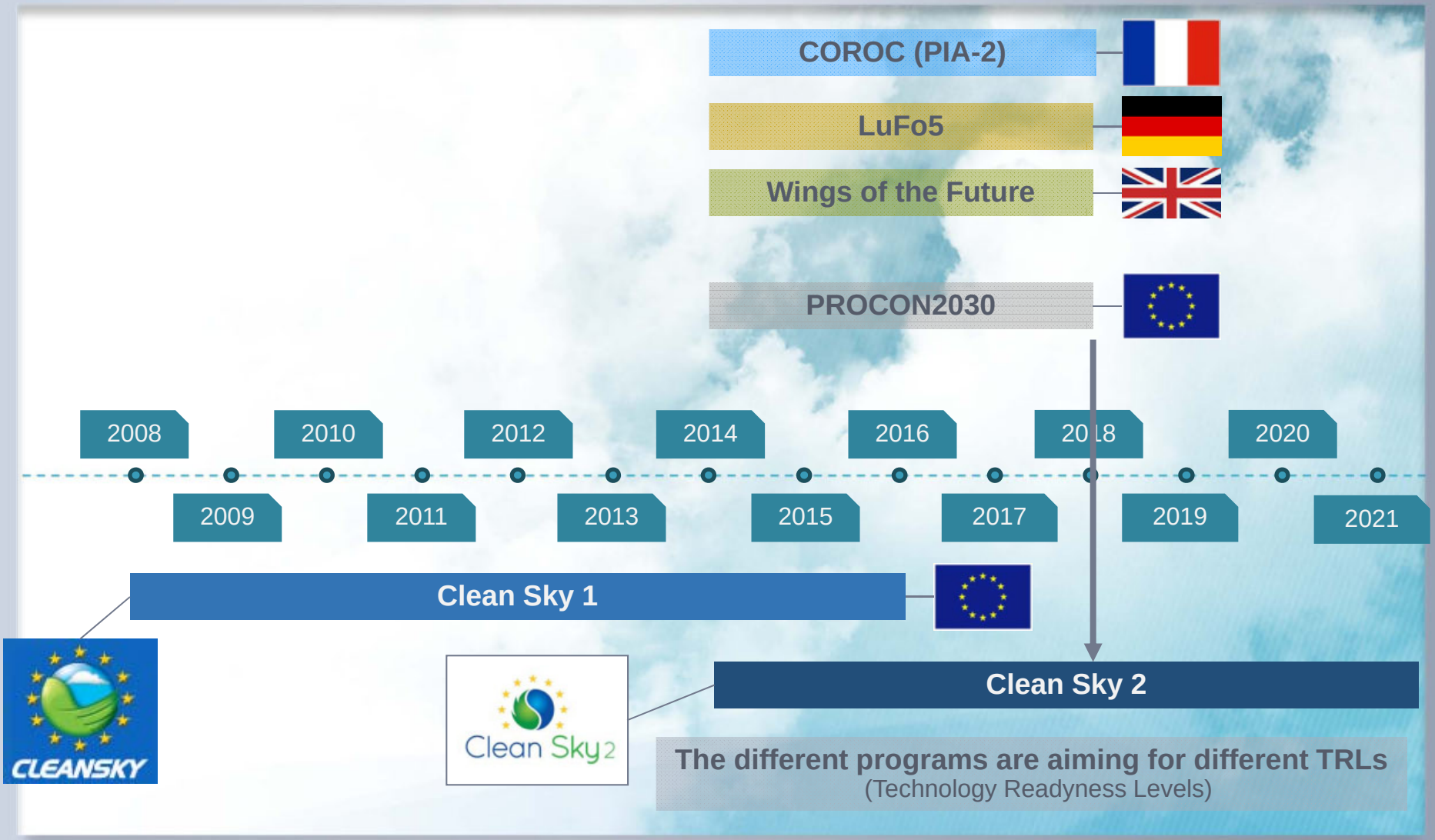
Green

Growth

PROCON Structure: targeting the challenge



PROCON in context of European research programs



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Conclusion

- A wide scope of opportunities and challenges in front of the air transport industry
- The current complex and well streamed technology maturation process may not be adapted for these challenges
- There is a need to develop processes and capabilities to address unconventional configurations and operations
- Proposal for a new research initiative (PROCON)
  - Synchronized with national projects
  - Better possibilities for European partners to participate in the industrial process