A350 XWB

A350 XWB family & technologies

Olivier Criou
A350 XWB Aircraft Configuration

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Contents

- A350 XWB family
- A350 XWB technologies
  - Configuration & structures
  - Engine
  - Aerodynamics
  - Systems
  - Cabin

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A350 XWB family

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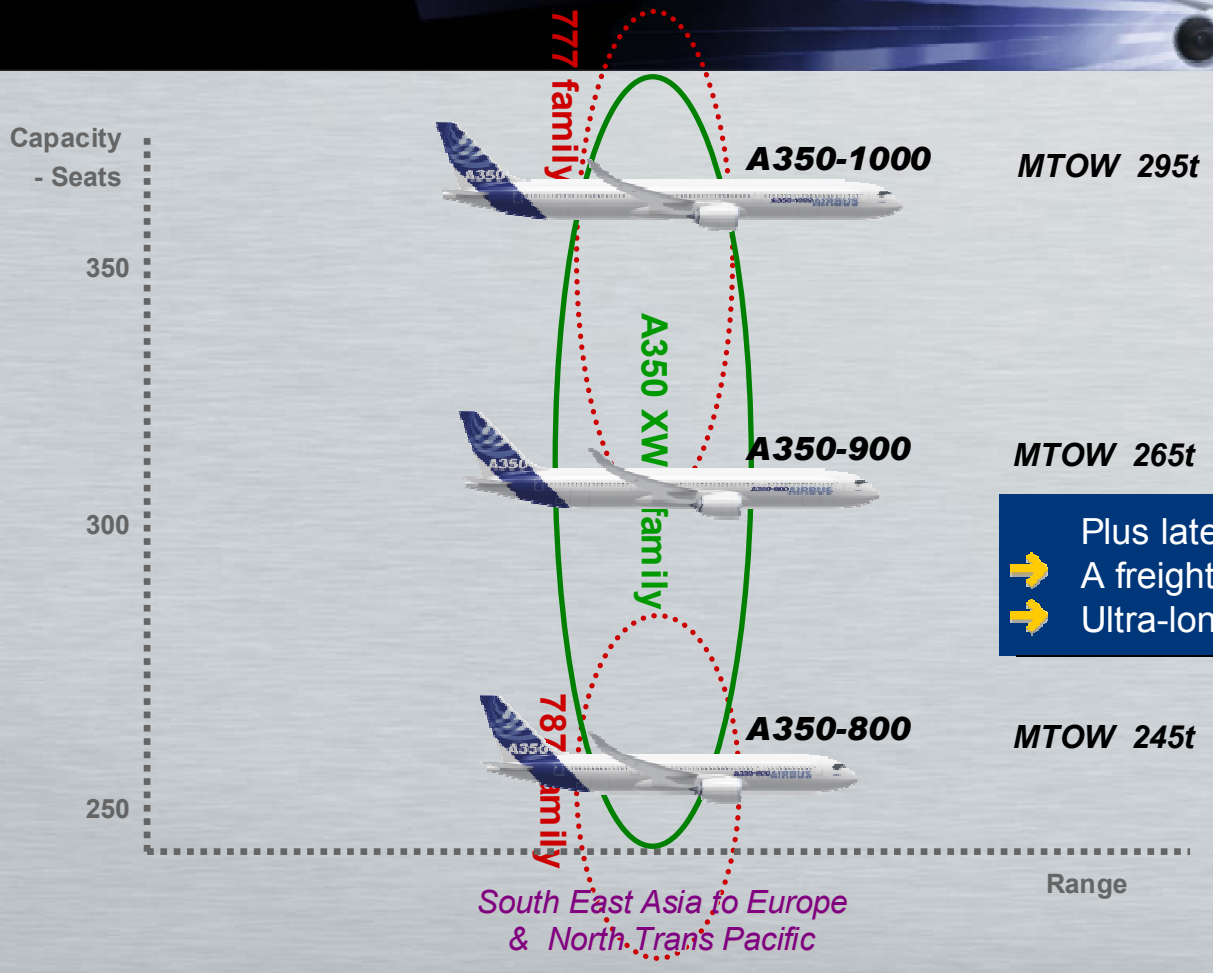
A350 XWB a wide ranging family



MTOW 295t Thrust 92klb

MTOW 265t Thrust 83klb

MTOW 245t Thrust 74klb

Plus later…..
- A freighter variant
- Ultra-long-range variant

A350 family offers a competitive answer to a wide range of applications

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A350 XWB Development Master Schedule

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Family Target Milestones	Concept Design Freeze	Detailed Definition Freeze			Final assembly start	First flight	EIS -900	EIS -800	EIS -1000
-900 Development Phases	Concept Optimisation & Testing (WTT, demonstrators ...) / Suppliers Selection (RSPs, cabin, systems, ...)	Specific Design Work (Industrial drawings, ...) & Manufacturing			Integration & Testing / Final Assembly Line		Flight Test Certification & Training		

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A350 XWB Family concept

A350-1000

+4 frames

+7 frames

A350-900

-4 frames

-1 frame

-5 frames

A350-800

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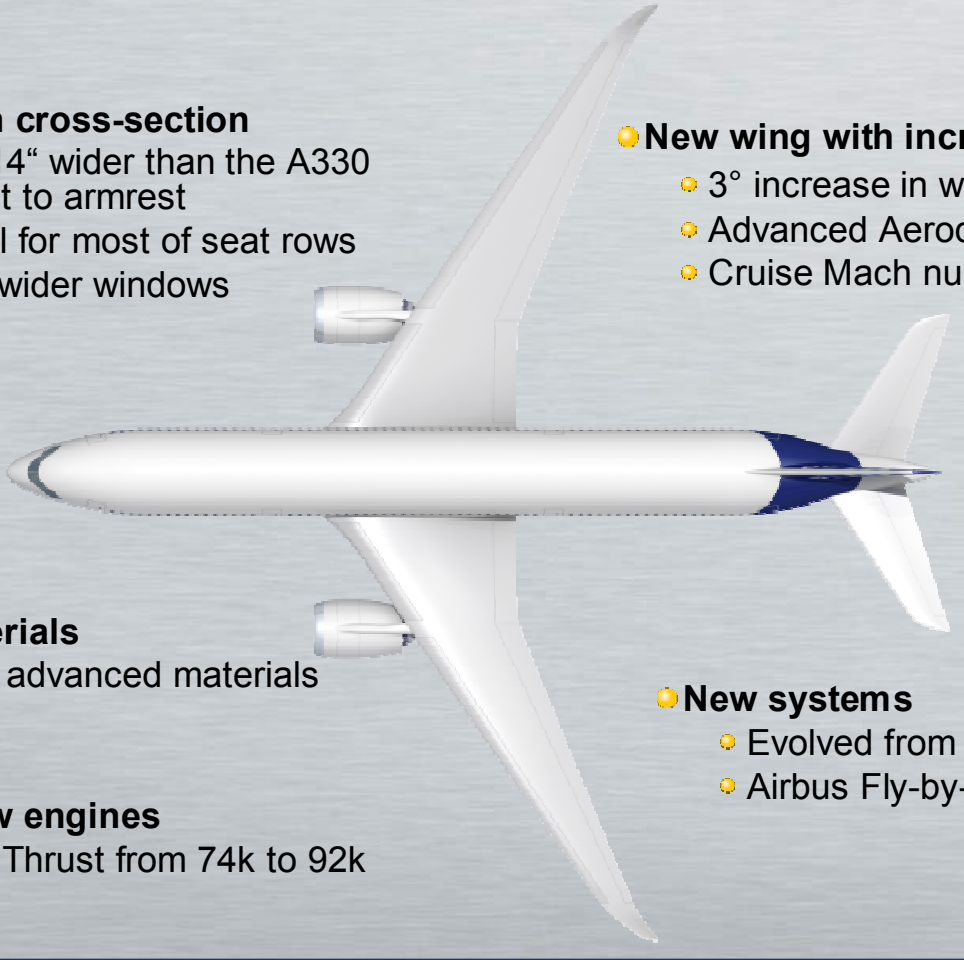
What is new on the A350 XWB?



- **New cabin cross-section**
  - Up to 14“ wider than the A330 armrest to armrest
  - Parallel for most of seat rows
  - 2 inch wider windows
- **New wing with increased sweep**
  - 3° increase in wing sweep (35°)
  - Advanced Aerodynamic design
  - Cruise Mach number at 0.85
- **New Materials**
  - >80% advanced materials
- **New systems**
  - Evolved from A380 technology
  - Airbus Fly-by-wire pilot commonality
- **New engines**
  - Thrust from 74k to 92k

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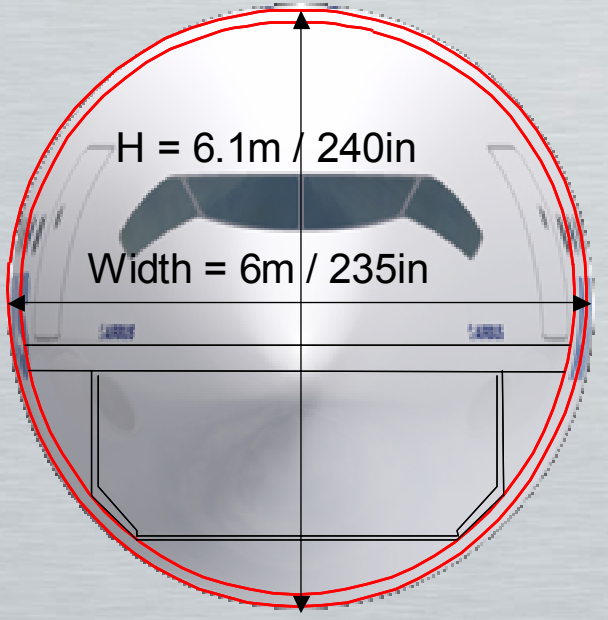
A350 XWB Cross section

- **Upper lobe sized for Cabin comfort**



- **Lower lobe sized by side-by-side LD3s**

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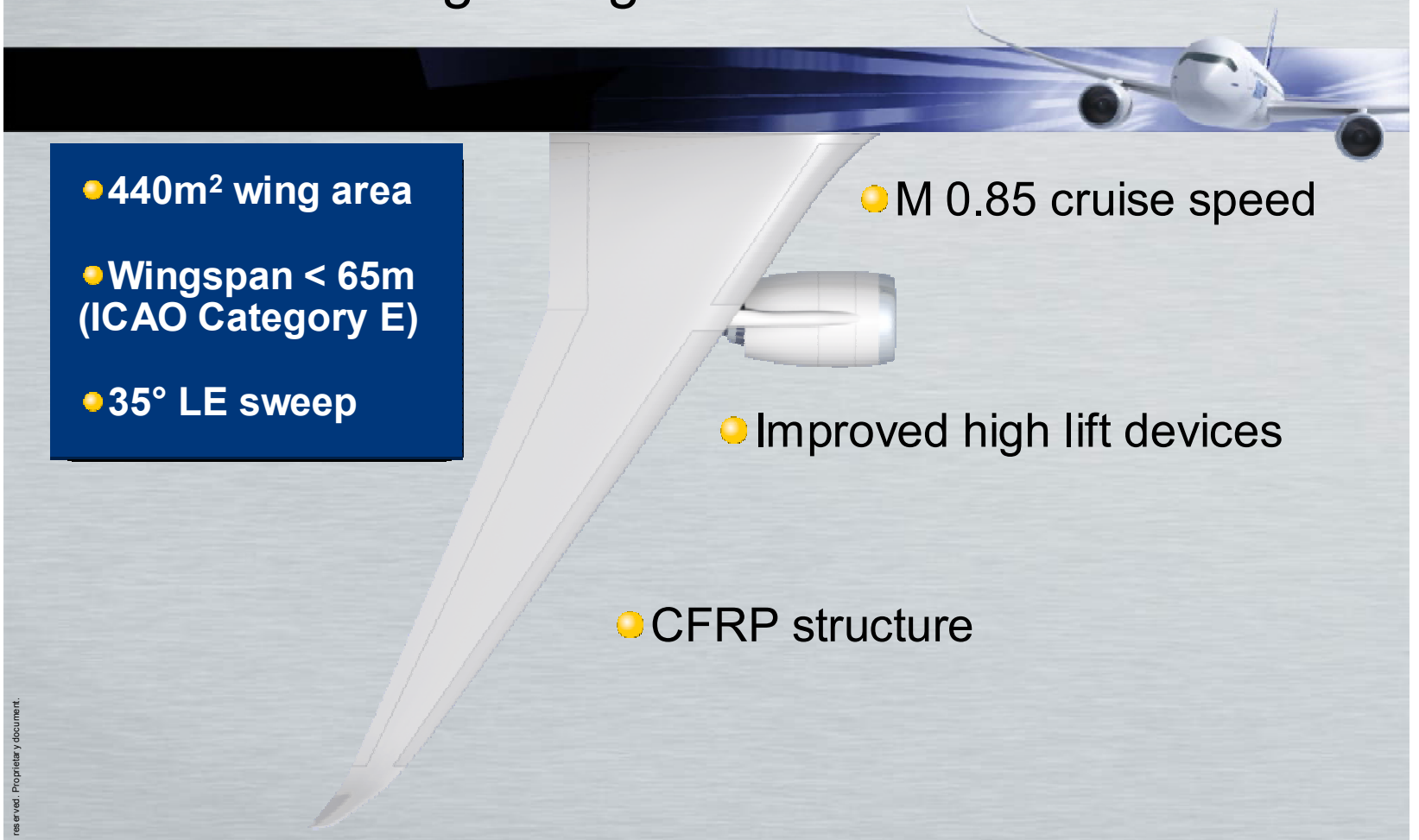
A350 XWB Wing Design



- **440m² wing area**
- **Wingspan < 65m (ICAO Category E)**
- **35° LE sweep**
- M 0.85 cruise speed
- Improved high lift devices
- CFRP structure
- Structural optimisation per variant

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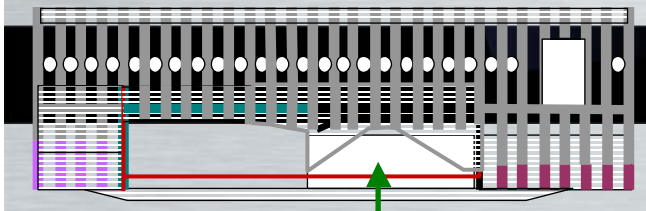
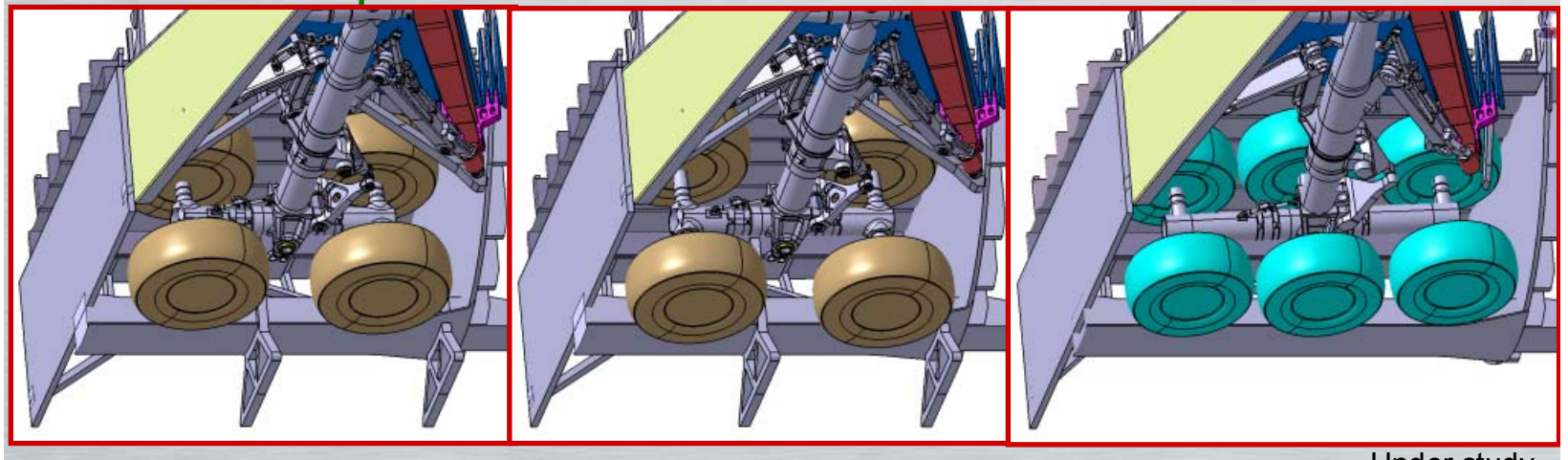
A350 XWB Main Landing Gear bay





Under study

A350-800
4-wheel bogie
4.1m bay

A350-900
Larger 4-wheel bogie
4.1m bay

A350-1000
6-wheel bogie
concept
4.7m bay

Messier-Dowty
SAFRAN Group

Landing gear optimisation per variant

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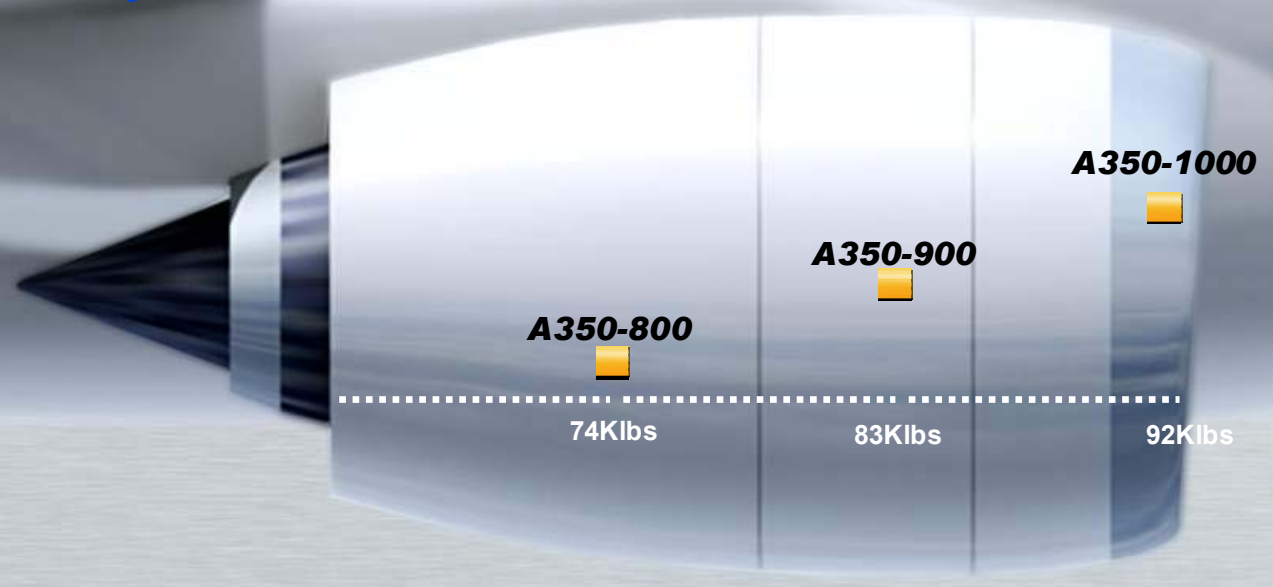
Xtra efficiency – next generation engines

Rolls-Royce Trent XWB



- Common engine type across aircraft family
- Low noise and emission levels
- Engine changes for the A350–1000 / 92k engine to enable optimisation of the A350–800/-900 engine

A350 XWB technologies

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A350 XWB technologies
Configuration and Structures

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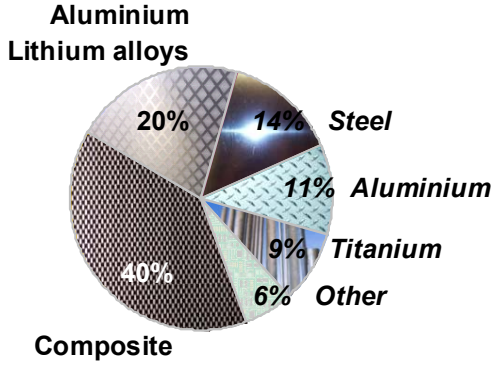
A350 XWB – Intelligent Airframe

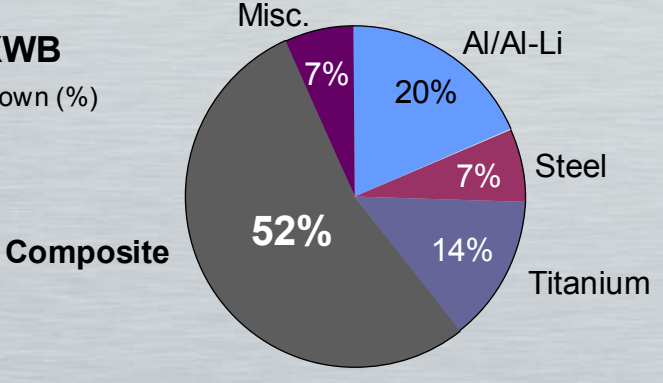
2005 A350 definition



A350-900 XWB

Material Breakdown (%)

Including Landing Gear



- **Materials selected to reduce airframe weight and to lower maintenance costs**

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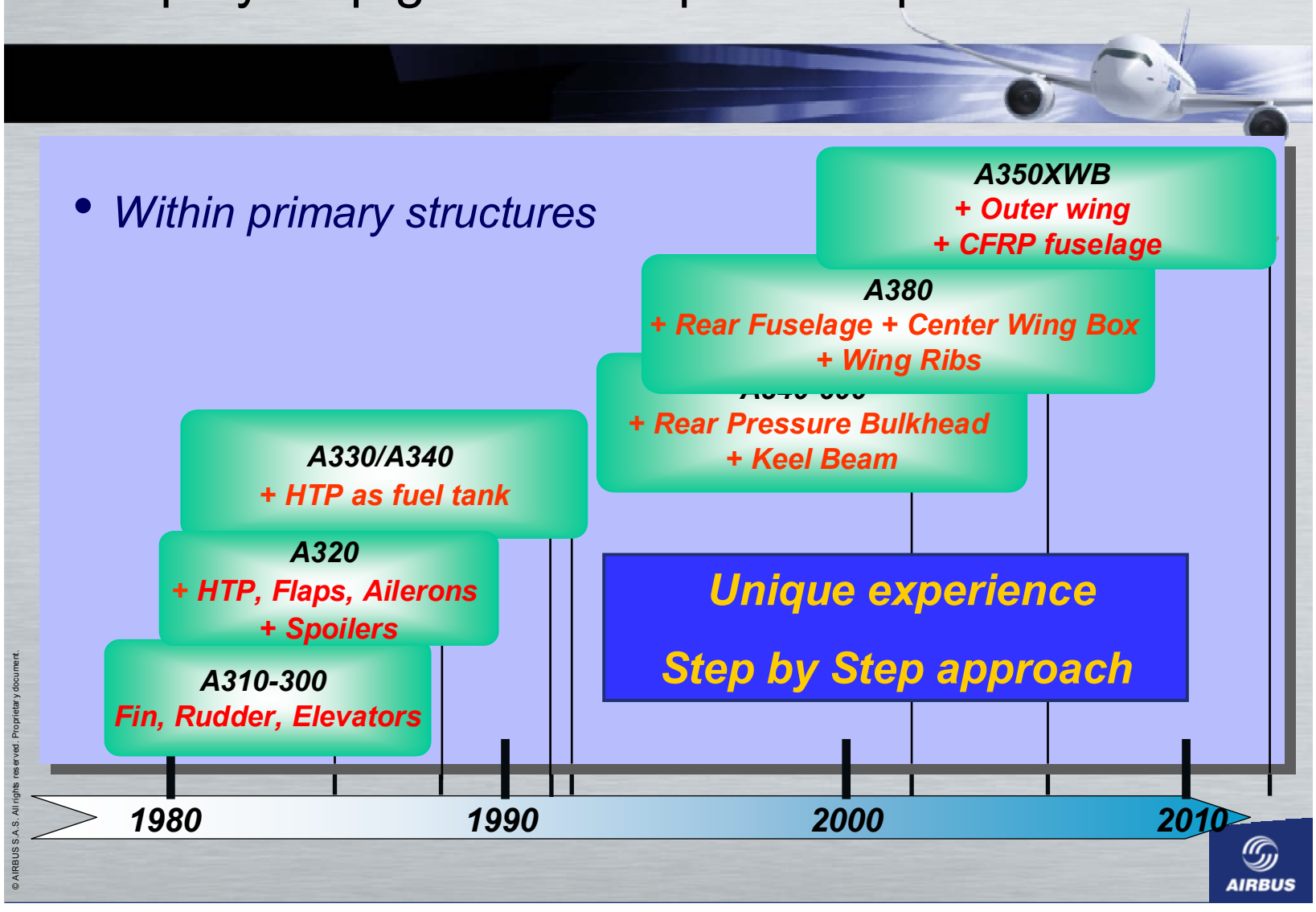
A step by step gain of composite experience



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CFRP technology

A380 CFRP center wing box

A400M CFRP wing box

We have extensive experience in composites

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CFRP technology

- Why CFRP fuselage on A350?
  - The A350 needed to change its design to answer to customer's expectation
  - This was the ideal opportunity & timing to make the next step: a CFRP Fuselage
  - Airbus existing research & solutions validated for:
    - Certification
    - Manufacturability
    - Repairability
  - We naturally include it on XWB

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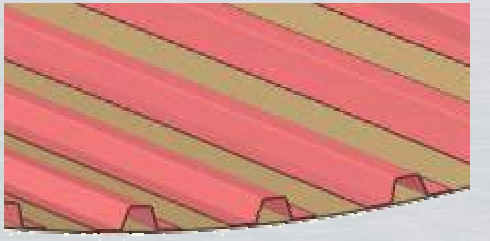
CFRP fuselage (1/2)

INNOVATION

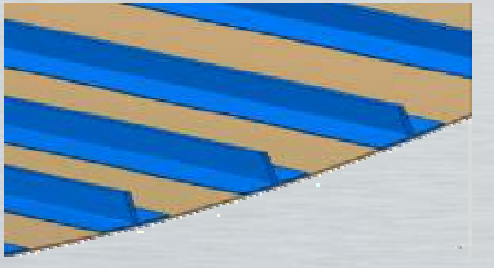
RATIONALE

- Reduce operational cost
- Reduce global environmental impact



SOLUTION

- Use of CFRP fuselage panels, doublers, joints & stringers, keel beam & typical frames



BENEFIT

- Fuel-burn savings through weight reduction: cost and environmental improvement
- Fatigue- and corrosion-free composites save maintenance costs

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CFRP fuselage (2/2)

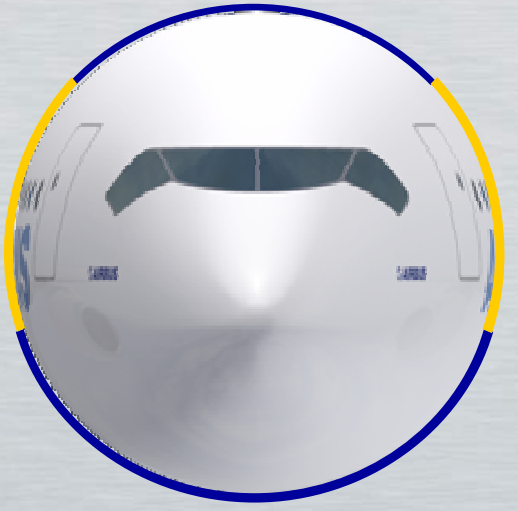
INNOVATION

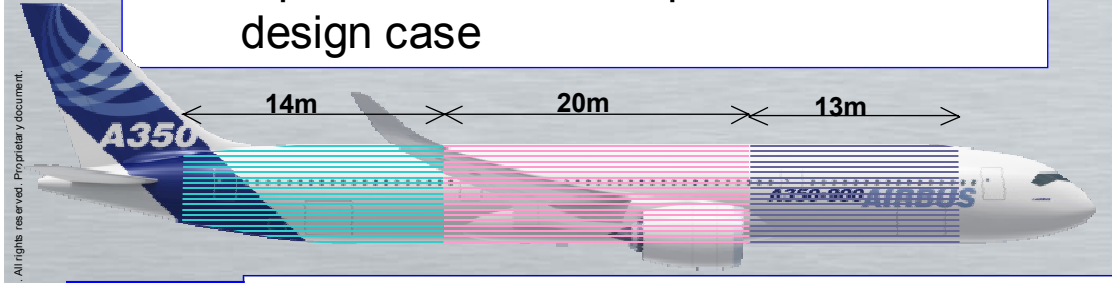
RATIONALE

- Reduce operational cost
- Reduce global environmental impact

SOLUTION

- Use of panel concept for CFRP fuselage
  - Panel as long as possible to reduce the amount of circumferential joints
  - Longitudinal joints participate in the fuselage bending strength
  - Optimisation of each panel for its design case





BENEFIT

- Panel concept is a light-weight CFRP fuselage solution

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Aluminium-Lithium in fuselage

INNOVATION

RATIONALE

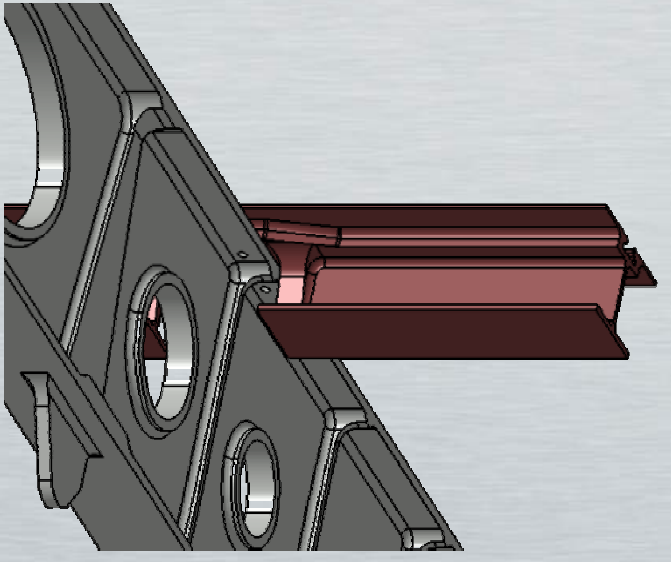
- Reduce operational cost
- Reduce global environmental impact

SOLUTION

- Use of Aluminium-Lithium for cross-beams, seat-rails in dry area and cargo floor structure: around -5% density reduction

BENEFIT

- Fuel-burn savings through weight reduction: cost and environmental improvement



e.g.: cross-beam & seat-rail

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CFRP Lightning protection

INNOVATION

RATIONALE

- Enable current flow in case of lightning on a CFRP fuselage

SOLUTION

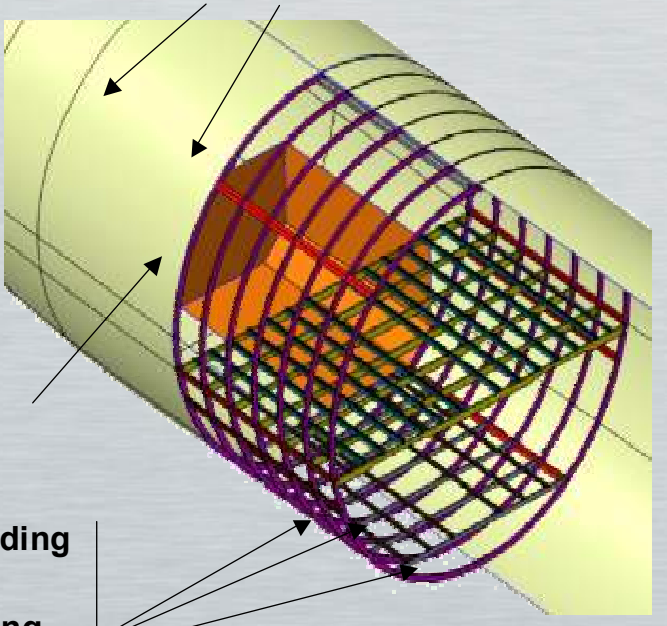
- Metallic mesh embedded in CFRP
- Metallic electrical network

BENEFIT

- Lightning protection

Lightning Direct Protection:

CFRP + Metallic Mesh



HIRF Protection:

CFRP

Grounding

Bonding

Voltage

Electrical network following frames and floorgrid

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CFRP Wing

INNOVATION

RATIONALE

- Reduce operational cost
- Reduce global environmental impact

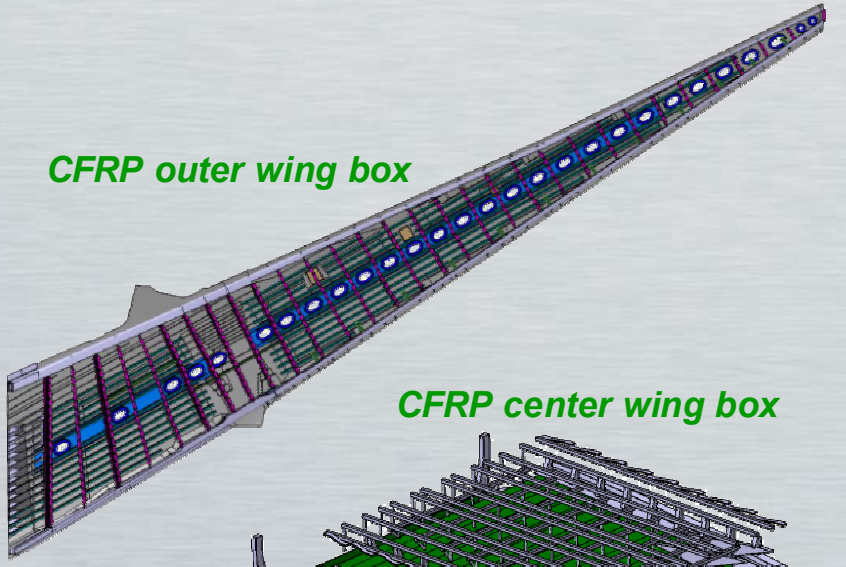
SOLUTION

- Use of CFRP spars, skins and stringers

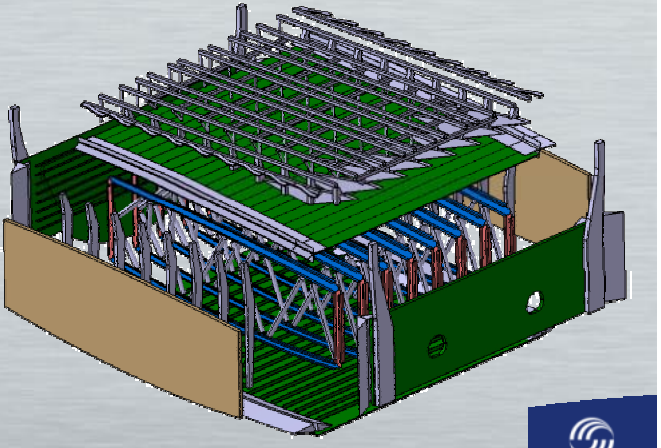
BENEFIT

- Fuel-burn savings through weight reduction: cost and environmental improvement
- Fatigue- and corrosion-free composites save maintenance costs

CFRP outer wing box



CFRP center wing box



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Aluminium-Lithium Wing Ribs

INNOVATION

RATIONALE

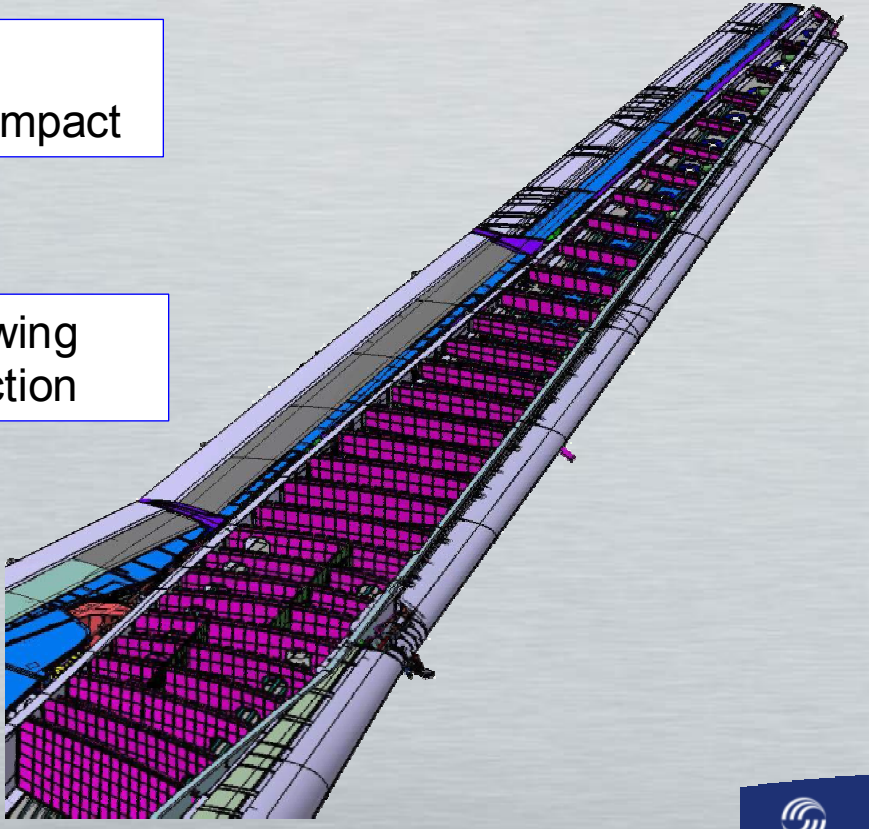
- Reduce operational cost
- Reduce global environmental impact

SOLUTION

- Use of Aluminium-Lithium for wing ribs: around -5% density reduction

BENEFIT

- Fuel-burn savings through weight reduction: cost and environmental improvement



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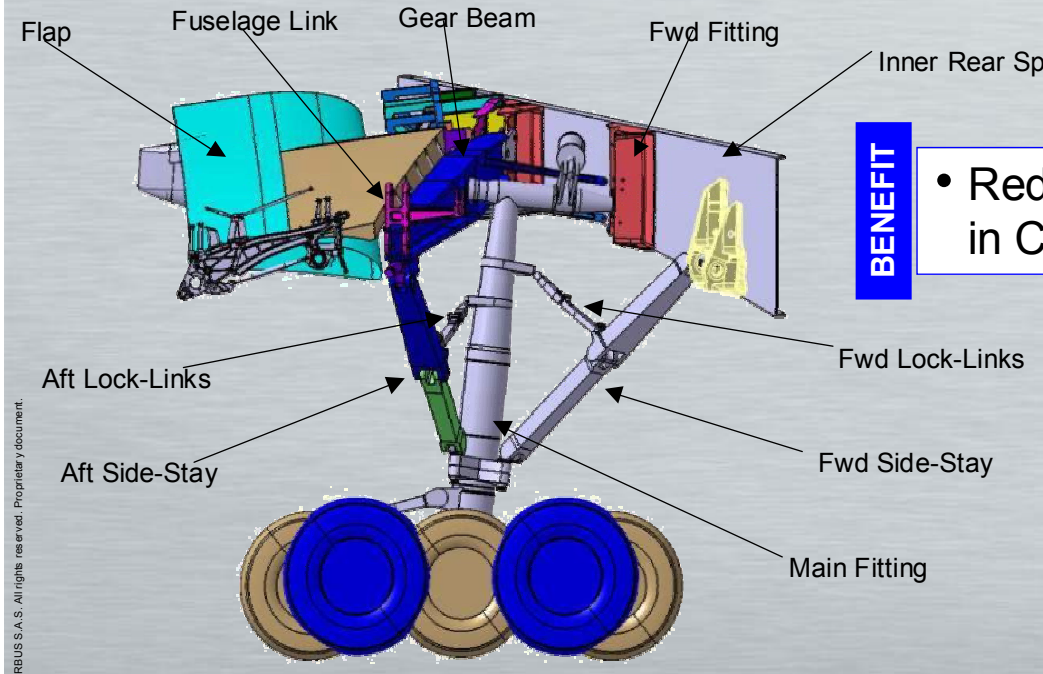
A350XWB Main Landing Gear Concept

RATIONALE

- CFRP wing requires adapted gear load introduction

SOLUTION

- Double side-stay landing gear attachment



BENEFIT

- Reduced point-load introduction in CFRP = weight saving

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Titanium – pylon & gears & highly loaded frames

RATIONALE

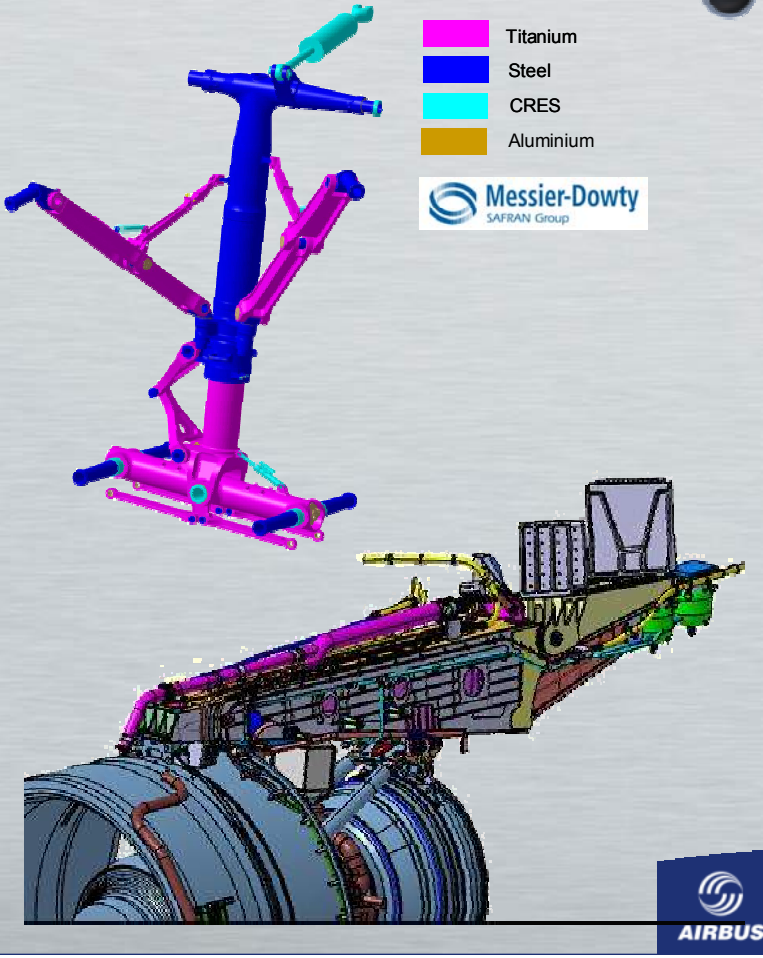
- Reduce operational cost
- Reduce global environmental impact

SOLUTION

- Titanium pylon primary structure
- Increased use of Titanium in landing gear
- Highly-loaded frames

BENEFIT

- Fuel-burn savings through weight reduction: cost and environmental improvement



A350 aft fuselage shaping

INNOVATION

RATIONALE

- Improve aircraft operability
- Improve operation costs

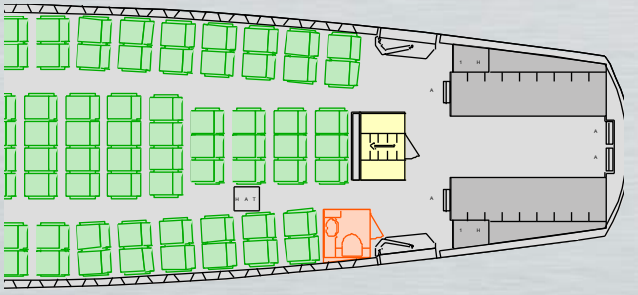
SOLUTION

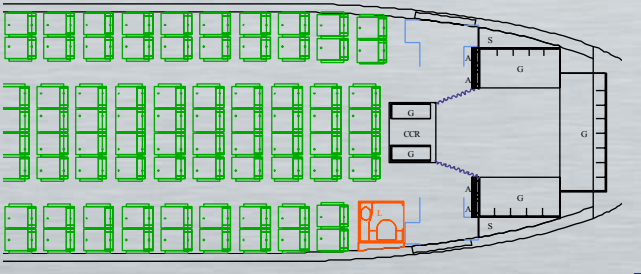
- More cylindrical cabin
- Most seat-rows in the cylindrical part

BENEFIT

- More seatcount-efficient fuselage
- Easier cabin use
- More efficient galley working area
- Fewer part number

A340



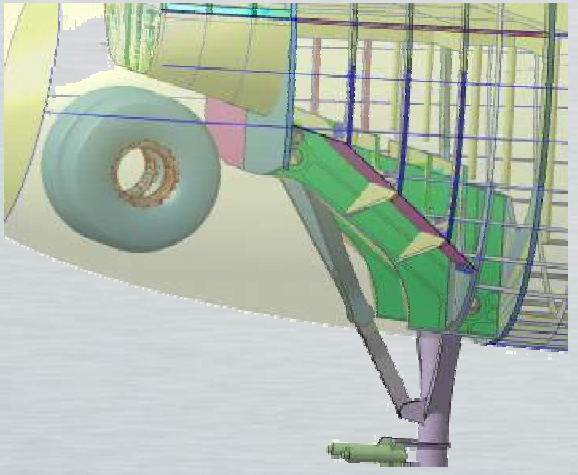


A350 XWB

A350 XWB Nose landing gear bay

SOLUTION

- A380-type Nose Landing Gear bay



BENEFIT

- reduced area pressurised structure = reduced weight
- Very useable volume freed for the avionics installation = easier operability of the EE-bay

Room-like EE-bay

A350 XWB technologies
Engine

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Xtra efficiency – next generation engines

INNOVATION

RATIONALE

- Reduce cost of operations
- Reduce local environmental impact
- Reduce global environmental impact

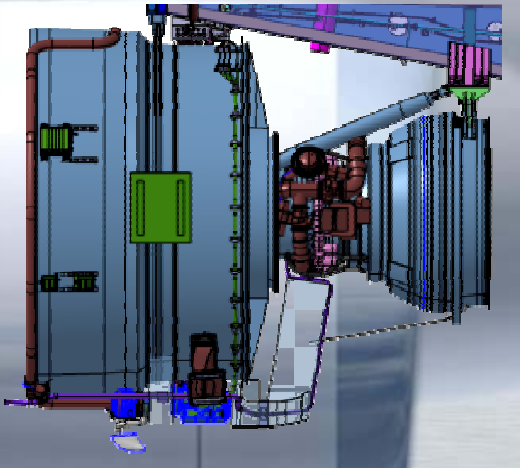
SOLUTION

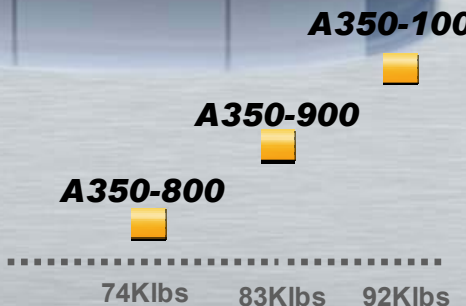
- Most modern jet engine: the Rolls-Royce Trent XWB

BENEFIT

- Low SFC: low fuel-burn
- Low maintenance costs
- Low emissions
- Low noise

Rolls-Royce Trent XWB





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A350 XWB technologies
Aerodynamics

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A350XWB extended laminar flow nacelle

UNDER STUDY

RATIONALE

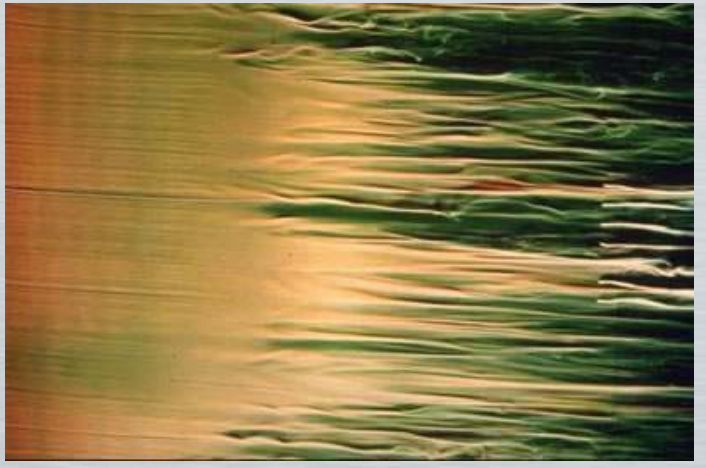
- Reduce operational cost
- Reduce global environmental impact

SOLUTION

- Nacelle with a higher proportion of natural laminar flow

BENEFIT

- Fuel burn reduction through drag saving: cost and environmental improvement



Delay of laminar-to-turbulent transition

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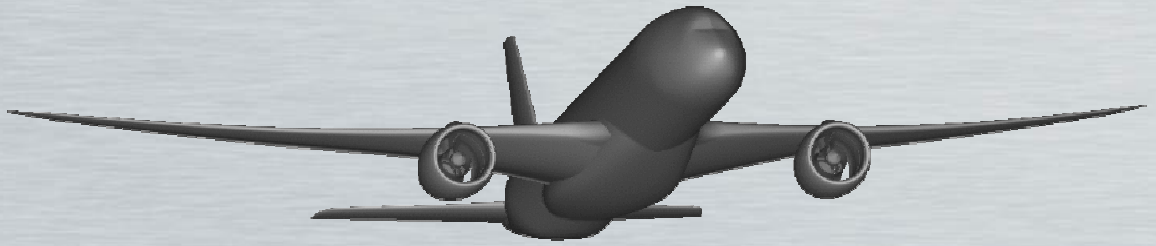
Aerodynamics Design

INNOVATION

RATIONALE

- Reduce operational cost
- Reduce global environmental impact

SOLUTION



Overall aircraft high-fidelity CFD

BENEFIT

- Outstanding accuracy for performance prediction, flight test proven
- Better representation of aerodynamics phenomenon turned into better design choices
- -40% WTT days in A350 aero development vs A380
- To date, ~6 months aero development time saving achieved

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A350 XWB Droop Nose

RATIONALE

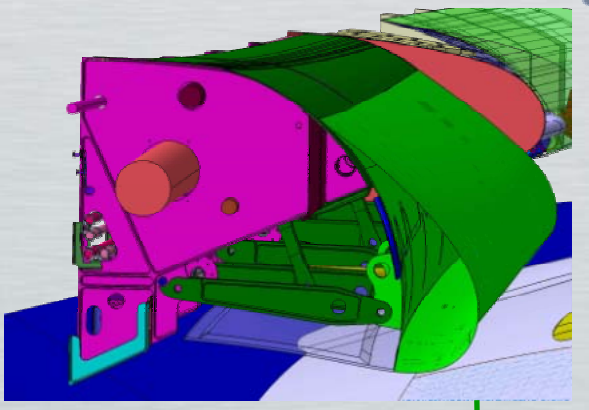
- Reduce cost of operations
- Reduce local environmental impact
- Reduce global environmental impact

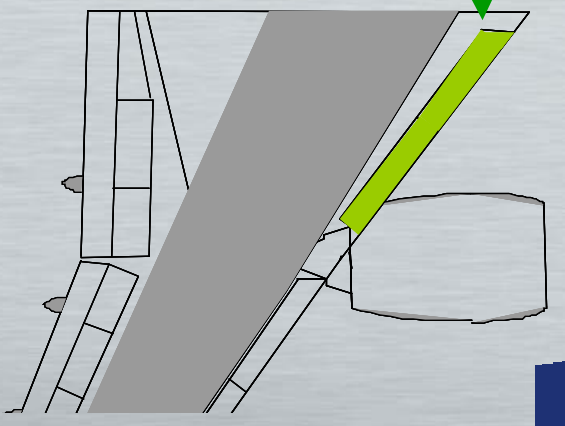
SOLUTION

- Droop-nose device on inboard wing

BENEFIT

- Low-speed drag savings
  - thrust need reduction > engine size reduced
    - – weight & drag savings > reduced cost of operations
    - – Maintenance cost savings
- Low-speed drag savings
  - Noise reduction





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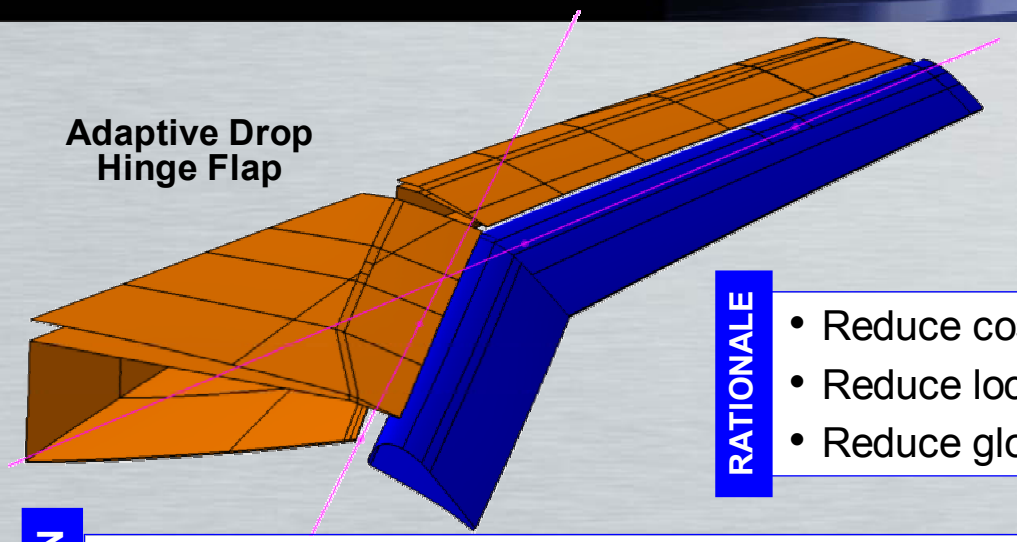
A350 XWB Adaptive Drop Hinge Flaps



RATIONALE

- Reduce cost of operations
- Reduce local environmental impact
- Reduce global environmental impact

SOLUTION

- Multifunctional trailing edge flap system: Adaptive Drop Hinge Flap
- Integrated use as high-lift device and for in-flight adaptation of cruise wing shape

BENEFIT

- Significantly improved High-Lift efficiency without increasing weight & complexity
- Load alleviation functions and cruise efficiency enhancement

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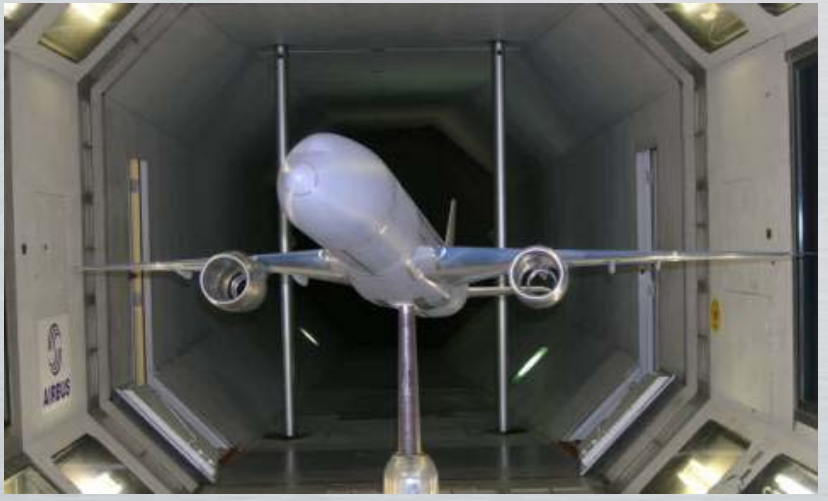
Aerodynamics Design Progress – Low Speed



- **Low speed wind tunnel test campaign in Bremen AIRBUS Facilities**
- **low speed wind-tunnel test campaigns in Filton AIRBUS facilities**
- **low speed wind-tunnel test campaigns in F1 ONERA facilities**

A350 XWB technologies
Systems

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A350 XWB systems

RATIONALE

- Reduce cost of operations
- Reduce global environmental impact

SOLUTION

- **2 hydraulic / 2 electric (2H/2E) flight control architecture**
  - Proven on A380 flight tests
- **4 variable frequency electrical generation systems**
  - Significant maintenance cost reduction
- **A380 Interactive Cockpit Concept with modular server systems**
  - + enhanced functionalities

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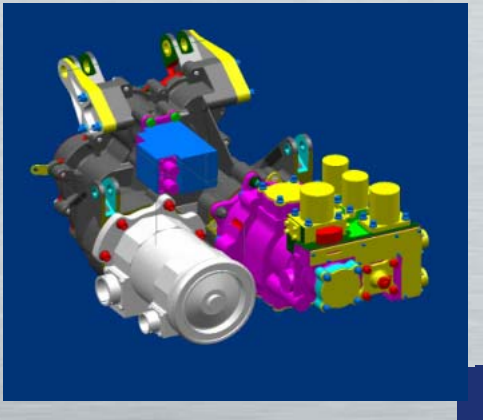
A350 XWB Flight Controls & Hydraulics 2H-2E architecture

- **'More electric' architecture**
  - Less pipes: less weight
  - Higher reliability
- **Electrically-powered Electro-Hydrostatic actuators (EHA)**
- **Electrically and Hydraulically powered Electrical Back-up Hydraulic Actuators (EBHA)**
- **Electrical motor for Slat Power Control Unit**
- **Electrical Ram Air Turbine**



BENEFIT

- maintenance costs reduction
- fuel burn reduction through weight savings

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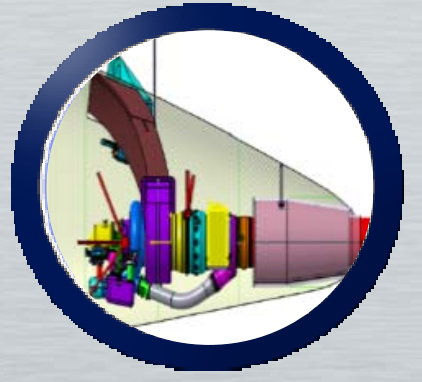
A350 XWB Electrical Systems

- **Generators**
  - 4 Variable Frequency Generators (4 x 100kVA)
  - ETOPS : 4 independent electrical sources / Dispatch with 1 Generator inoperative
  - Smaller, lighter, more reliable

- **APU**
  - 1 APU Starter/Generator (1 x 150kVA)



BENEFIT

- Reduced costs of operations through reduced maintenance costs, improved reliability

- **230 VAC network**

BENEFIT

- Reduced costs of operations by weight savings (feeders)

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A350 XWB Cockpit and Avionics

- **A380 interactive cockpit (CDS) and Avionics**
- **Integrated Modular Avionics**
  - Standard computing modules
    (Line Replaceable Module) running several applications
- **A380 experience**
- **+ enhanced functionalities**

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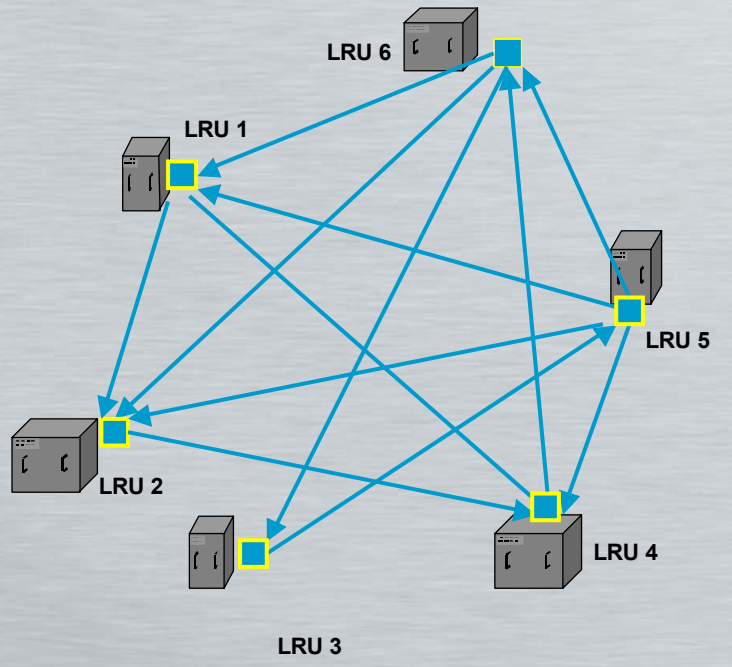
A350 flightdeck baseline

- **Advanced cockpit based on A380 design with dual HUD option**

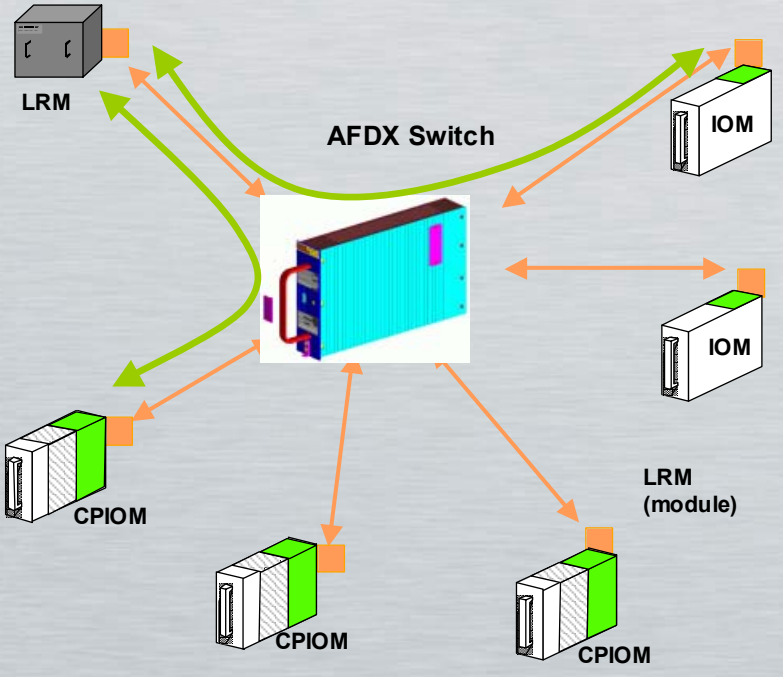
Avionics

A330 ARINC 429



- 1 new link = 1 new cable

A350 AFDX Technology



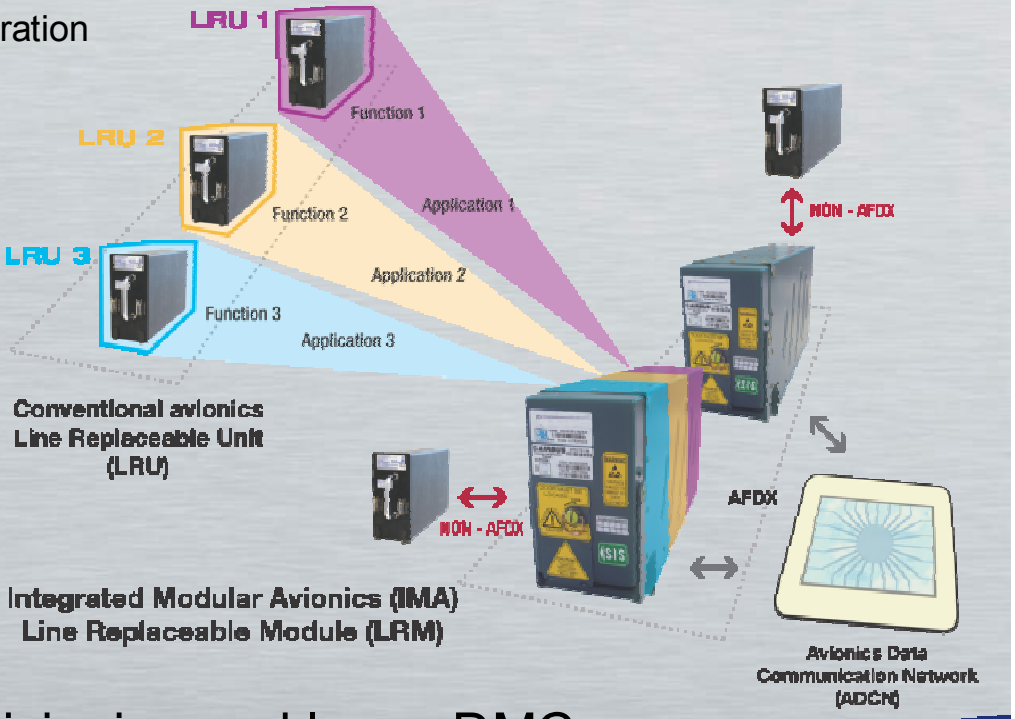
- Fewer connections, easier Maintenance & T/S
- Higher re-configuration flexibility

- Less labour expenditure, hence lower DMC

Avionics

- >50% less avionic LRUs
- Simplified upgrade implementation
- Reduced spare inventory administration

A350
Integrated Modular Avionics



- Less provisioning and lower DMC

AIRBUS

A350 XWB

Cabin & Crew Rests

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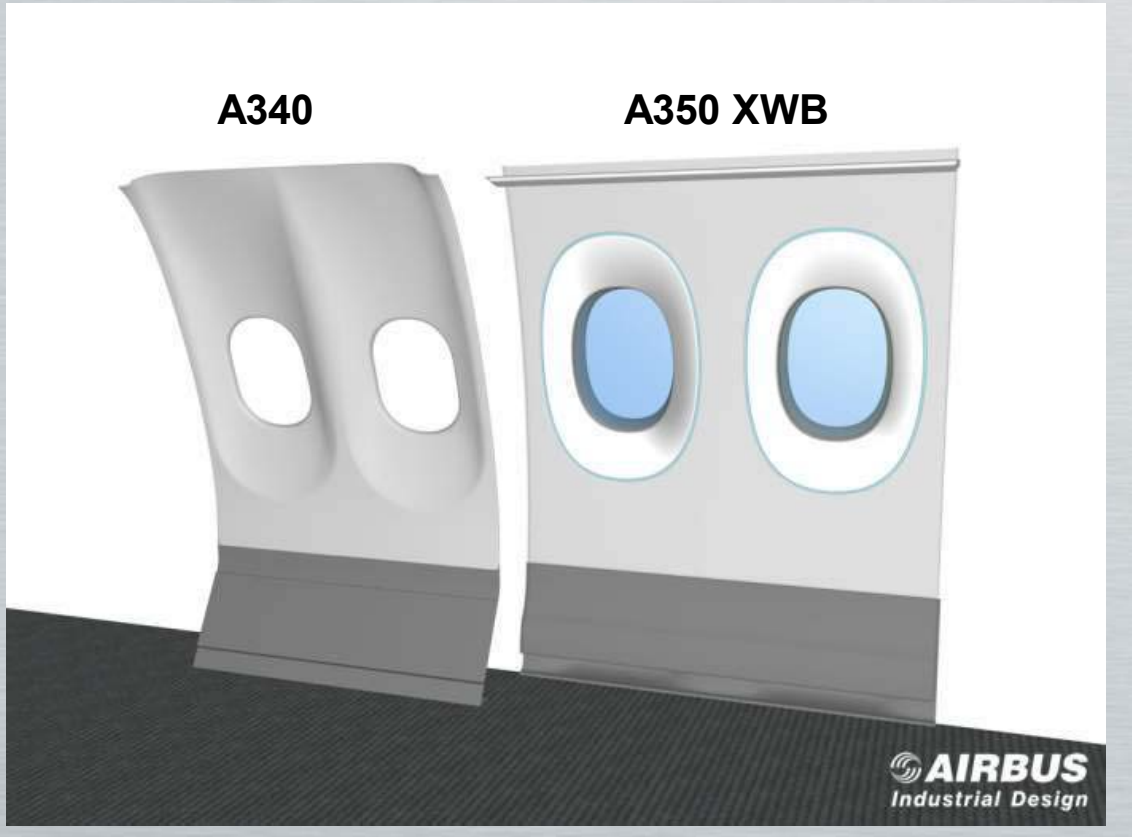
Widest high-efficiency Economy seat

- **Uncompromised comfort at high efficiency: 17.5 inch seat width**

A350 Windows Comparison

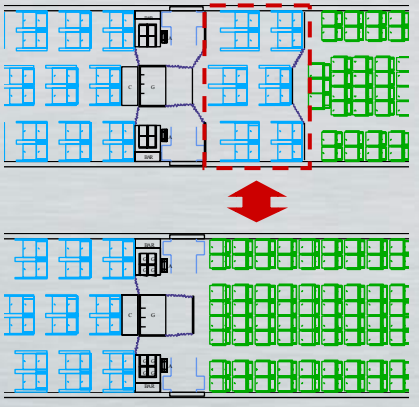


> +50 %

A350 XWB: Aim at Setting New Standards of Cabin Reconfiguration

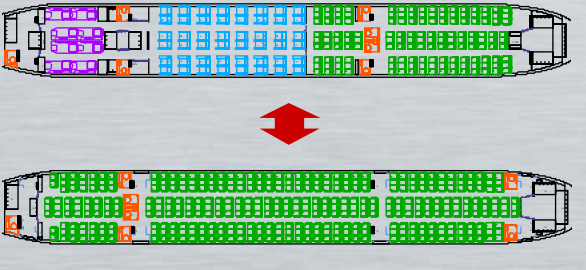
Short term flexibility

- Typical reconfiguration to handle seasonal fluctuations
- **Overnight** change



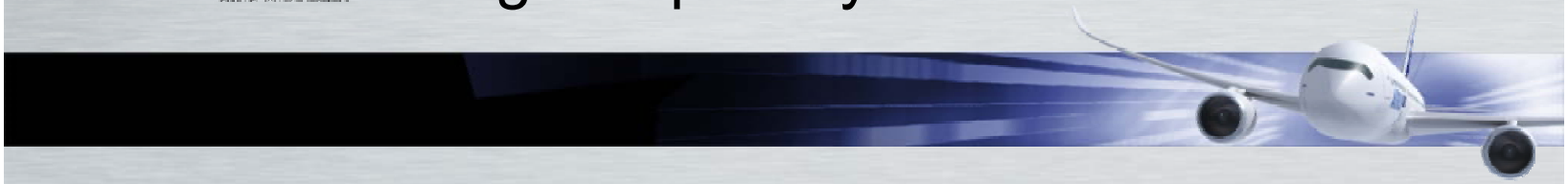
Long term flexibility

- Typical reconfiguration to adapt to market changes
- Achievable within **5 days**

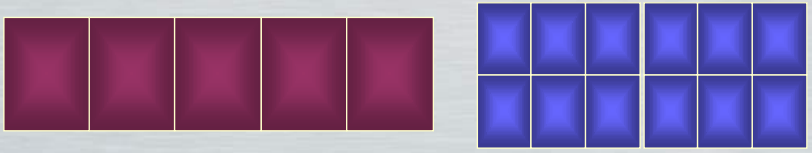


- **Placed for the first time as a top level aircraft requirement**

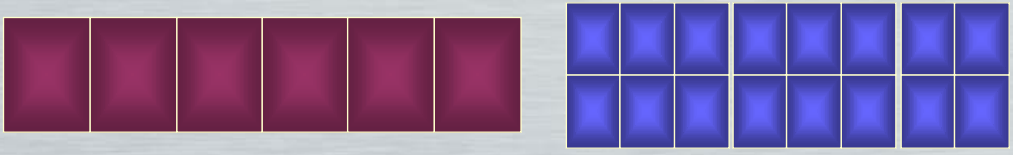
A350 XWB Cargo Capability



A350-800
5 pallets + 12 LD3s



A350-900
6 pallets + 16 LD3s



A350-1000
8 pallets + 18 LD3s

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A350 XWB Crew rest compartents

- No impact on revenue space

Summary

- Through weight savings, aerodynamics standard and low SFC, A350 XWB is contributing to fuel burn savings:
  - Reduced cost of operations
  - Reduced impact on the environment
- The choice of structure material and systems philosophy provides outstanding performance and reduced cost of maintenance
- A350XWB has the latest generation of engines:
  - Low noise
  - Low emissions
  - Low maintenance costs
  - Low fuel burn

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A350 XWB

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