A350 XWB family & technologies

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A350 XWB Aircraft Configuration
Contents

• A350 XWB family

• A350 XWB technologies
  ‣ Configuration & structures
  ‣ Engine
  ‣ Aerodynamics
  ‣ Systems
  ‣ Cabin
A350 XWB family
A350 family offers a competitive answer to a wide range of applications

- **A350-1000**
  - MTOW: 295t
  - Thrust: 92klb
- **A350-900**
  - MTOW: 265t
  - Thrust: 83klb
- **A350-800**
  - MTOW: 245t
  - Thrust: 74klb

South East Asia to Europe & North Trans Pacific

Plus later.....
- A freighter variant
- Ultra-long-range variant
A350 XWB Development Master Schedule

Family Target Milestones
- 2007: Concept Design Freeze
- 2008: Detailed Definition Freeze
- 2009: Final assembly start
- 2010: First flight
- 2011: EIS -900
- 2012: EIS -800
- 2013: EIS -1000

-900 Development Phases
- Suppliers Selection (RSPs, cabin, systems, ...)
- Concept Optimisation & Testing (WTT, demonstrators ...)
- Specific Design Work (Industrial drawings, ...) & Manufacturing
- Integration & Testing
- Final Assembly Line
- Flight Test Certification & Training
A350 XWB Family concept

A350-1000

A350-900

A350-800

+4 frames

+7 frames

-4 frames

-1 frame

-5 frames
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
Upper lobe sized for Cabin comfort

- $H = 6.1\text{m} / 240\text{in}$
- Width = $6\text{m} / 235\text{in}$

Lower lobe sized by side-by-side LD3s
A350 XWB Wing Design

- 440m² wing area
- M 0.85 cruise speed
- Wingspan < 65m (ICAO Category E)
- Improved high lift devices
- 35° LE sweep
- CFRP structure
- Structural optimisation per variant
A350 XWB Main Landing Gear bay

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

Landing gear optimisation per variant

Under study
Xtra efficiency – next generation engines

- 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
A350 XWB – Intelligent Airframe

Materials selected to reduce airframe weight and to lower maintenance costs

2005 A350 definition

- Aluminium: 11%
- Lithium alloys: 20%
- Steel: 14%
- Titanium: 9%
- Other: 6%
- Composite: 40%

A350-900 XWB Material Breakdown (%)

- Composite: 52%
- Steel: 7%
- Titanium: 14%
- Al/Al-Li: 7%
- Misc.: 7%

Airframe structure composition by material:

- Belly fairing
- Ribs, floor beams, gear bays...

Materials selected to reduce airframe weight and to lower maintenance costs
A step by step gain of composite experience

- **Within primary structures**
  - A330/A340
    + HTP as fuel tank
  - A320
    + HTP, Flaps, Ailerons, + Spoilers
  - A310-300
    Fin, Rudder, Elevators
  - A340-600
    + Rear Pressure Bulkhead, + Keel Beam
  - A350XWB
    + Outer wing, + CFRP fuselage
  - A380
    + Rear Fuselage + Center Wing Box, + Wing Ribs
  - A350XWB
    Unique experience
    Step by Step approach
CFRP technology

A380 CFRP center wing box

A400M CFRP wing box

We have extensive experience in composites
• 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
CFRP fuselage (1/2)

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
CFRP fuselage (2/2)

**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
Aluminium-Lithium in fuselage

**INNOVATION**

**RATIONALITY**
- 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
CFRP Lightning protection

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
Electrical network following frames and floorgrid
Voltage
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
- Fatique- and corrosion-free composites save maintenance costs

**CFRP outer wing box**

**CFRP center wing box**
Aluminium-Lithium Wing Ribs

RATIONAL
• 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
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
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
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
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
A350 XWB technologies
Aerodynamics
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
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
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
- Noise reduction
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

Adaptive Drop Hinge Flap
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 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
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

Benefits:
- maintenance costs reduction
- fuel burn reduction through weight savings
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)
  - Reduced costs of operations through reduced maintenance costs, improved reliability

**230 VAC network**
  - Reduced costs of operations by weight savings (feeders)
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
A350 flightdeck baseline

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

A330 ARINC 429

- LRU 1
- LRU 2
- LRU 3
- LRU 4
- LRU 5
- LRU 6

A350 AFDX Technology

- LRM
- CPIOM
- IOM

- 1 new link = 1 new cable
- 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
A350 XWB
Cabin & Crew Rests
Widest high-efficiency Economy seat

- Uncompromised comfort at high efficiency: 17.5 inch seat width
A350 Windows Comparison

A340

A350 XWB

> +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 Cargo Capability

A350-800
5 pallets + 12 LD3s

A350-900
6 pallets + 16 LD3s

A350-1000
8 pallets + 18 LD3s
A350 Crew rest compartments

Overhead cabin crew rest

Overhead flight crew rest

- 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
Thank You!