GEA Tianjin / 中国民航大学中欧航空工程师学院

SB5 5th Semester Program

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Avionics and Air Traffic Control Systems Specialty

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Flight Management and Guidance Systems

Presented by Vincent de LABORDERIE and Lionel BOMPART

FOREWORD

- Understanding
  - Ask question, do not hesitate to interrupt
- Acronymes
  - Many acronyms exists in the Aircraft world, and even in engineering classes, they can not be avoided ➔ ask for clarification
- Questions
  - No dumb question.
- Course supports

SCHEDULE

	8:00 – 8:50 8:55 - 9:45		10:05 - 10:55 11:00 - 11:50		13:30 – 14:20 14:25 - 15:15		15.35 – 16:25 16:30 - 17:20		18.30 - 20:15
THURSDAY Oct 20th	**INTRODUCTION Handling Qualities Part 1**	BREAK	**Handling Qualities Part 2**	LUNCH	**Flight Controls Part 1**	BREAK	**Flight Controls Part 2**	DINNER	
FRIDAY Oct 21th	**Auto Flight System Part 1**	BREAK	**Auto Flight System Part 2**	LUNCH	**Automatic Control applied to Laws**	BREAK		DINNER	
SATURDAY Oct 22th									
SUNDAY Oct 23th									
MONDAY Oct 24th	**Intermediate Exam (2h)**	BREAK	**Flight Management System Part 1**	LUNCH	**Flight Management System Part 2**	BREAK	**Displays systems**	DINNER	
TUESDAY Oct 25th	**Other systems**	BREAK	**Human Factors**	LUNCH	**Validation & Flight Tests**	BREAK	**FINAL EXAM**	DINNER	

The EXAMS

- A first one with open questions (Monday)
- A second one with Multi-Choice Questionnaire type
  - 4 choices
  - Only one good answer

- No document allowed during the exam

- No mobile phone, Laptop, Translator, …

SUMMARY

SUMMARY

3.1 : Flight Control System (5h)

- Introduction
- Description of Flight Control System
- Flight Control Architecture
- Pilot Flight Controls
- Flight Parameters display
- Flight Control Laws: from Stability Augmentation to Full Authority protections
- Stability & Control, Handling Qualities, Flying Qualities…
- Stability Augmentation
- Full Authority Control Laws: longitudinal & lateral
- Full Authority Protections
- Failure cases & reconfigurations
- Flight Control Laws design techniques: classical and multi-dimensionnal approaches
- Fly-by-Wire architecture: safety and reliability issues

SUMMARY

4 : Auto Flight System (4h)

- General
- Architectures
- General principles
- Evolution
- Airbus architecture
- AFS components
- Overview
- Interfaces HMI
- Modes, logics
- Protections / Warnings
- Approach/Autoland
- Airworthiness requirements
- AFS Innovations

5 : Automatic control applied to Flight Control Laws (2h)

- Introduction : Nz (C*) Law
- Into practice

SUMMARY

SUMMARY

8 : Human Factor (2h)

- Introduction
- Accidents examples
- Application on a coherence project on AFS modes

9 : Validation (2h)

- Introduction
- Ground Tests
- Flight Tests

Myself

- 1996 : Engineering diploma of POLYTECHNIQUE
- 1998: Engineering diploma of SUPAERO – ISAE
- 1998 : Master of Science, UC Berkeley (USA)

- 1998: Systems engineer at Lufthansa Technik (Germany)

- 2000: Systems engineer at Delphi Automotive

- 2000: Head of Flight control and autopilot systems at Sagem

- 2004: WP Leader for A400M new Avionics in AIRBUS
- 2010 : Head of Multy-Systems Architecture in AIRBUS
- 2014: Head of Flight Control Laws in AIRBUS

AIRBUS COMPANY

Airbus designs, sells, builds and supports the most modern and comprehensive aircraft family in the world thanks to:

- Unrivalled flexibility across four aircraft families, all of which have been developed in response to customer needs
- 74,000 employees around the world, including France, Germany, Spain, the UK, North America, China, Japan and Russia
- A global network of over 330 customers and 400+ operators
- Close working relationships with its shareholder EADS

AIRBUS COMPANY

Airbus' achievements by the end of 2015 included

- An annual turnover of €45,8 billion
- A gross market share (units) of 49%
- Delivering 635 aircrafts and selling 1080
- Surpassing 16,200 aircrafts ordered by 330+ customers
- Supporting 9000 aircrafts in service with 400+ operators
- Regularly achieving over 50% of large civil aircraft orders and deliveries

The **Airbus** Family

A320 Family

The market leader

A330 Family

The right aircraft, right now

A350 XWB

The Xtra that makes a difference

A380

Own the sky

Same

- ***flight deck***
- ***handling***
- ***procedures***
- ***task sharing***
- ***flight deck systems***
- ***Maintenance***

1 Integrated family

Commonality brings benefits

STR

Same Type Rating

"A single qualification to fly aircraft of different size and/or weight which share the Same Type Certificate"

CCQ

Cross Crew Qualification

"Qualifying from one aircraft type to another by doing Difference Training rather than a full Type Rating"

MFF

Mixed Fleet Flying

"One pool of pilots, flying different aircraft types"

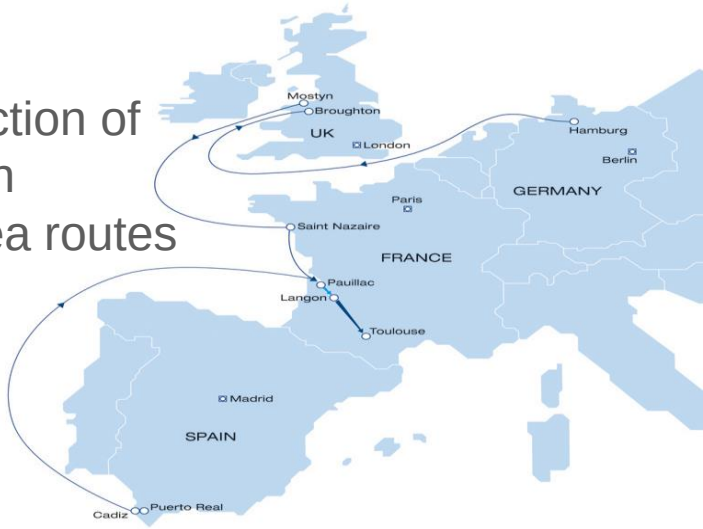
Airbus transport

The Beluga

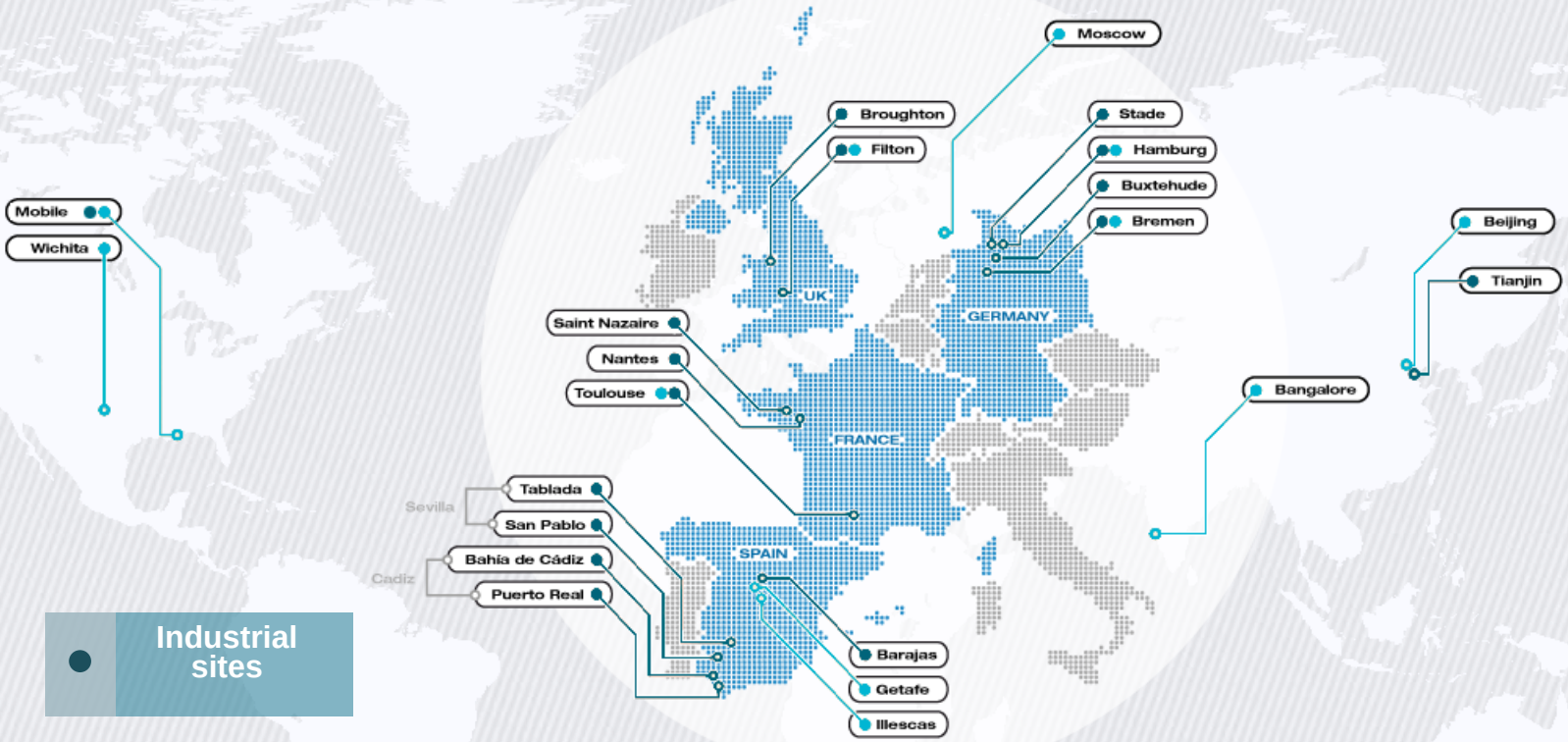
- The most voluminous cargo hold in the world transports complete aircraft sections from Airbus' 16 manufacturing sites across Europe to the final assembly lines in Hamburg and Toulouse

Innovative logistics

- The transport system has been further optimised for the A380 with the introduction of custom built vehicles that operate on an integrated network of road, river and sea routes



Airbus today



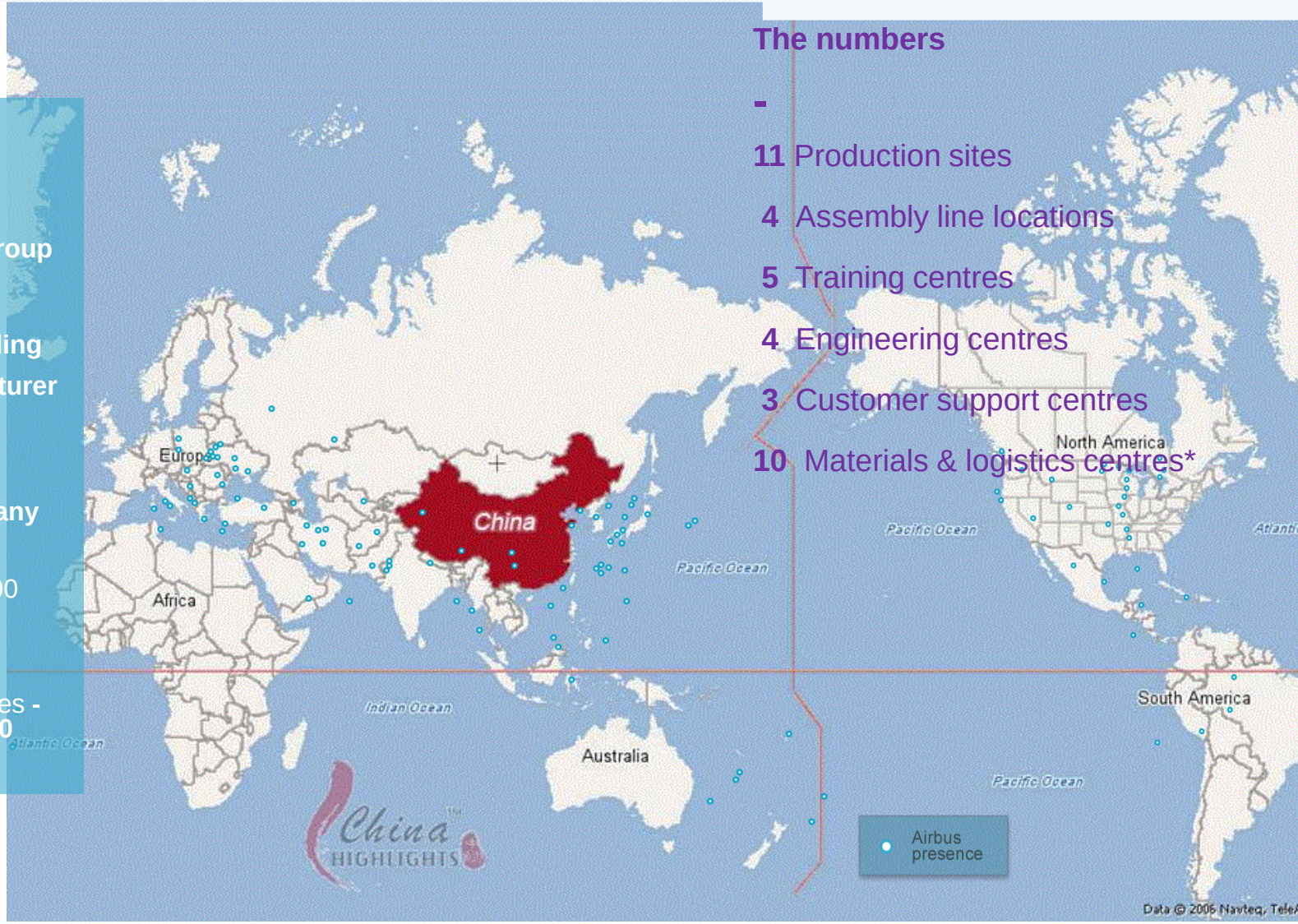
Industrial sites

Engineering centres

Industrial sites and engineering centres

Airbus: a global company

- **Part of Airbus Group**
- The world's **leading aircraft manufacturer**
- **One integrated company**
- More than 7 600 **aircraft** in operation
- **59,000** Employees **- more than 100 nationalities**



The numbers

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11 Production sites

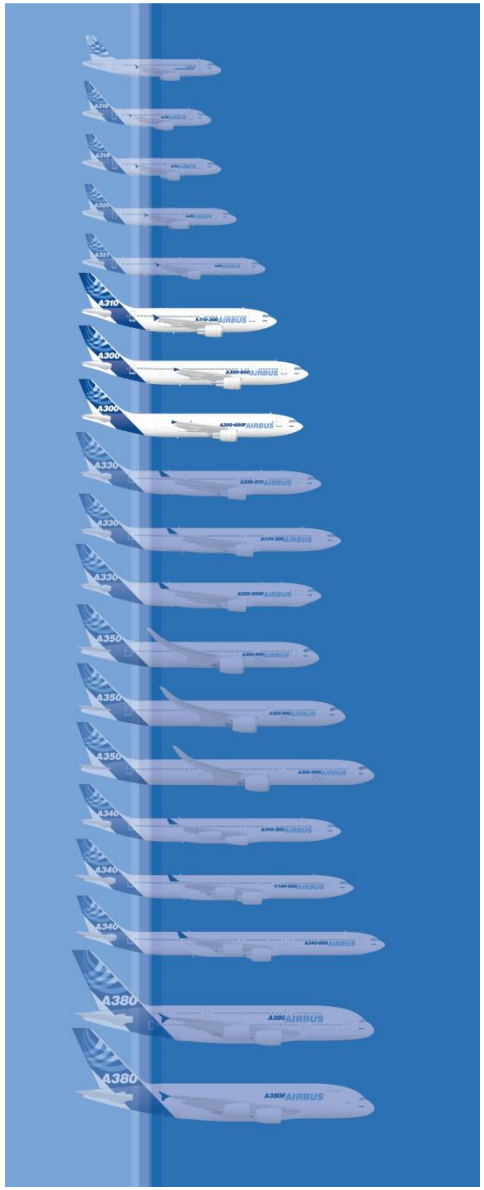
4 Assembly line locations

5 Training centres

4 Engineering centres

3 Customer support centres

10 Materials & logistics centres*



The A300/A310 Family

Strong foundations from which to grow

- The first Airbus aircraft
- The first twin engine widebody
- The first civil aircraft with a forward-facing two man cockpit
- The first civil aircraft with composites in secondary, and then primary structures
- The first civil aircraft to feature drag reducing wing tip devices

THE AIRBUS AIRCRAFTS

- The WB family

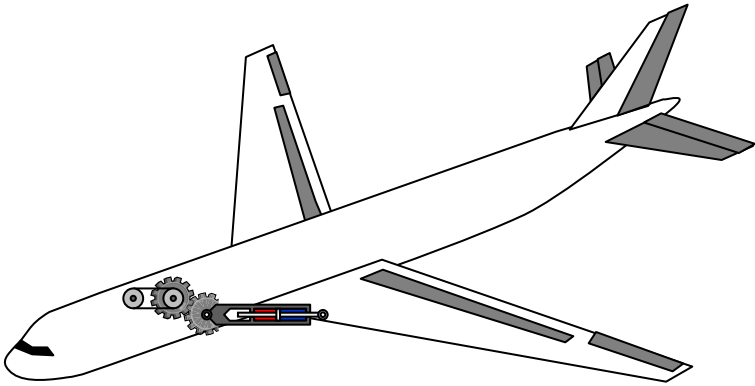
WB for Wide Body, ie a wide fuselage.

Mechanical flight controls except for spoilers on A310.

A300

266 pax

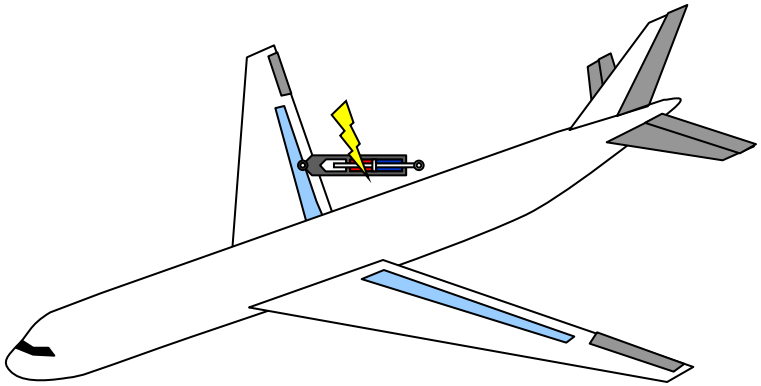
7500 km



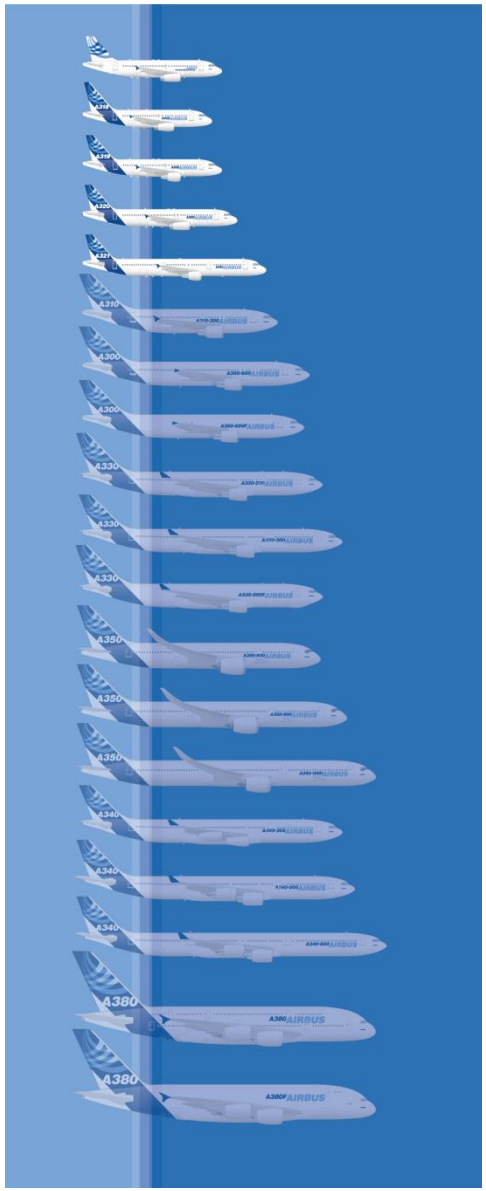
A310

220 pax

9600 km



THE AIRBUS AIRCRAFTS



The A320 Family

The versatile answer for profitability

- The world's best selling aircraft family
- The widest single-aisle aircraft
- The first civil aircraft with full fly-by-wire and side stick control
- The lowest operating cost and highest residual values in its class
- The only business jet certified for public transport
- The first civil aircraft to have a composite tailplane and flaps

THE AIRBUS AIRCRAFTS

- THE SA FAMILY

SA for Single Aisle.

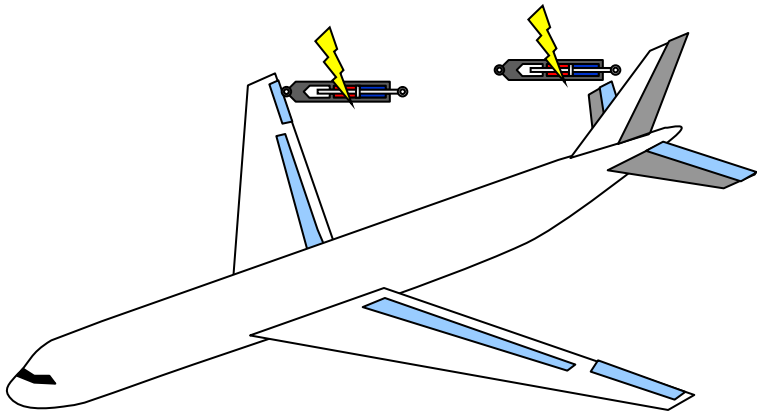
The first electrical flight controls. Rudder and horizontal stabilizer are still mechanical.

A321
185 pax
3 000 nm

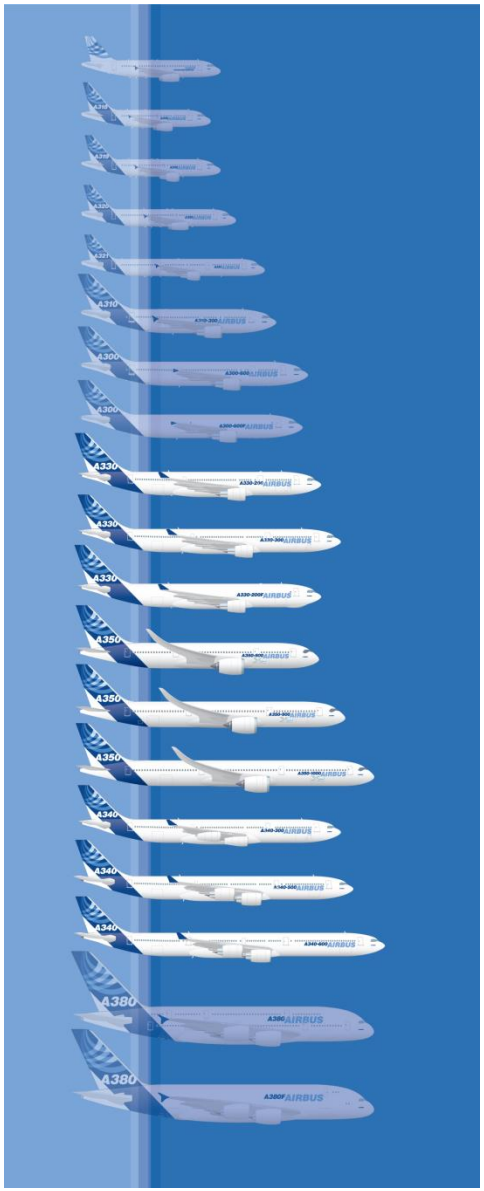
A320
150 pax
3 000 nm

A319
124 pax
3 500 nm

A318
107 pax
2 800 nm



THE AIRBUS AIRCRAFTS



The A330/A340/A350 Family

The most comfortable cabin in the sky

- The most technologically advanced and fuel efficient civil aircraft on the market
- The most spacious and quiet cabins
- The first civil aircraft with a composite rear pressure bulkhead and keel beam (A340)
- 60% advanced materials (A350 XWB)

THE AIRBUS AIRCRAFTS

- THE LR FAMILY (Long Range)

They are « basics » ou « enhanced », meaning that they have or not an electrical rudder control.

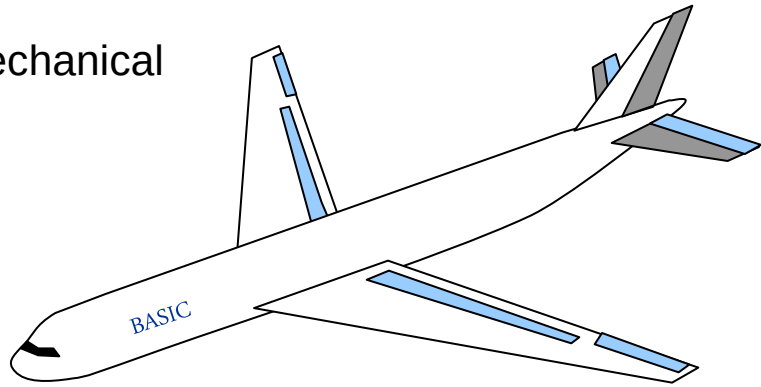
The horizontal stabilizer is still mechanical

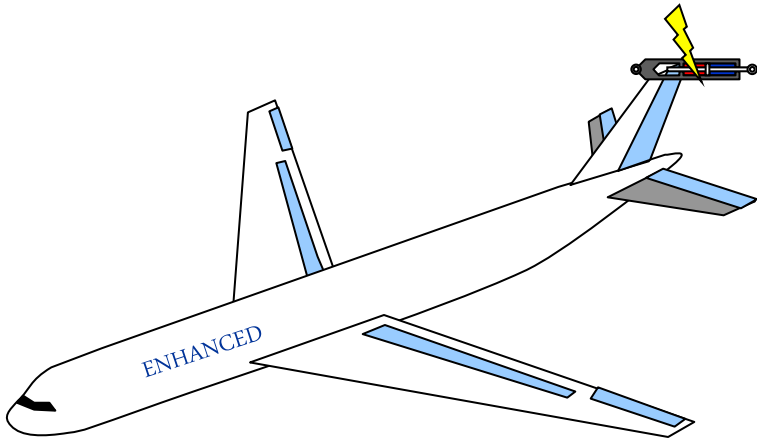
A340-200
250 pax
13 000 km

A340-300
278 pax
13 000 km

A330-300
278 pax
10 000 km

A330-200
246 pax
12 000 km



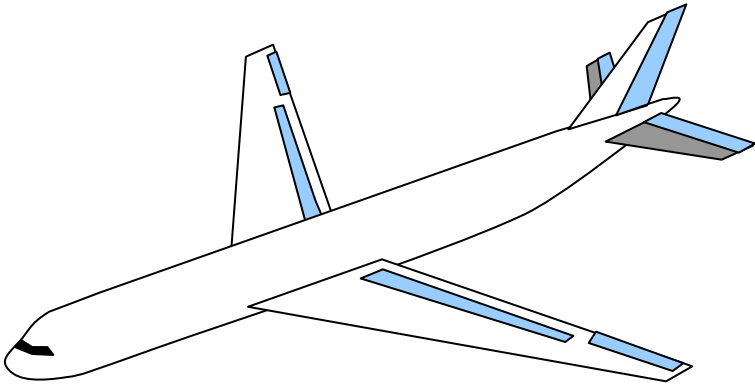


THE AIRBUS AIRCRAFTS

- LR FAMILY : (WBI)

More range, more passengers, flight control system like Enhanced Long Range

A340-500
297 pax
15 800 km



The A340 and WBI program has been stopped on 10th November 2011. No more commands could be passed.

THE AIRBUS AIRCRAFTS

- THE XWB FAMILY (A350)

Nowadays a very innovative aircraft:

-30 cm more wider for the fuselage and wider windows

-Mach 0.85

-Carbon Wing and fuselage

-New engines

-New nose design

-New system architecture but in the respect of the Airbus family concept

-Exploitation cost and performance similar to B787

THE AIRBUS AIRCRAFTS

- THE XWB FAMILY (A350)

Extra Wide fuselage in comparison with A330, carbon fuselage and full electrical like A400M and A380.

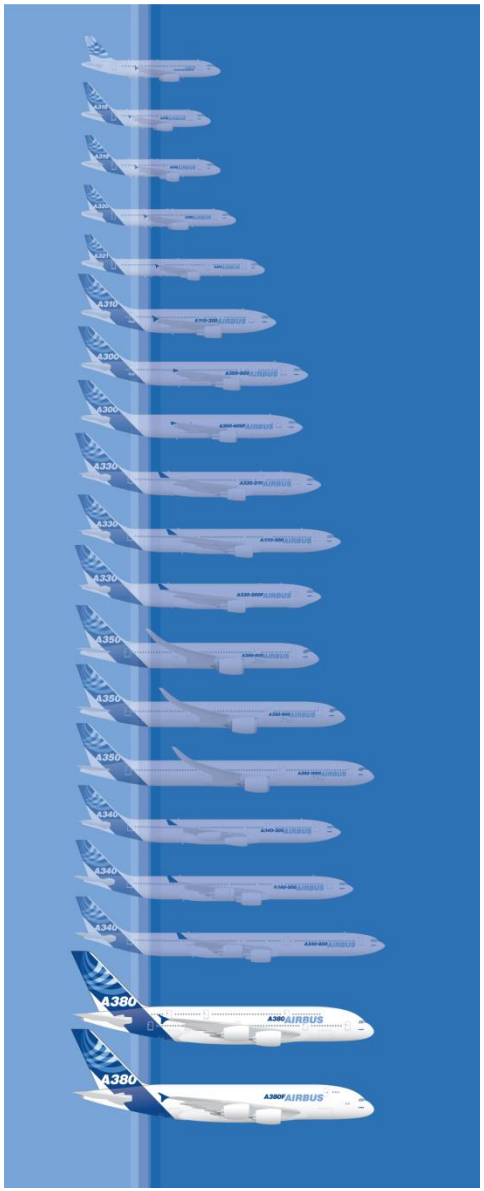
A350

-800 270 pax
-900 314 pax
-1000 350 pax

15700 km

First flight done in June 2013

THE AIRBUS AIRCRAFTS



The A380 Family

The flagship of the 21st century

- Airbus' response to growing demands on transport
- The most spacious and comfortable cabin available
- The most technologically advanced aircraft in commercial production today
- The first civil aircraft structure to incorporate 25% composites
- The highest level of environmental performance in its class
- New hydraulic electric system

THE AIRBUS AIRCRAFTS

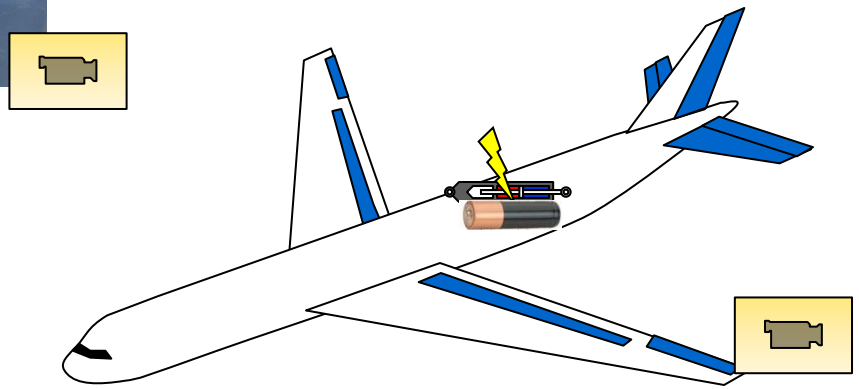
- THE A380 FAMILY

Full electrical flight control system and some high power electrical source for redundancy instead of hydraulical

A380

550/850 pax

14 000 km



THE AIRBUS AIRCRAFTS

- A400M

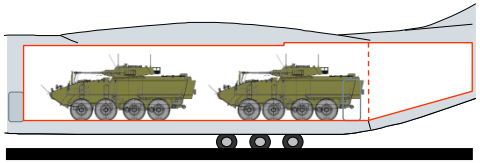
Idem A380

A400M

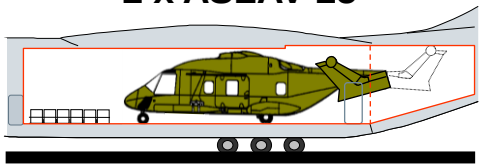
4500 km 30t

ou

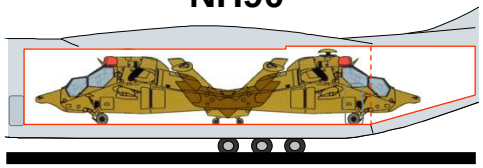
6500 km 20t



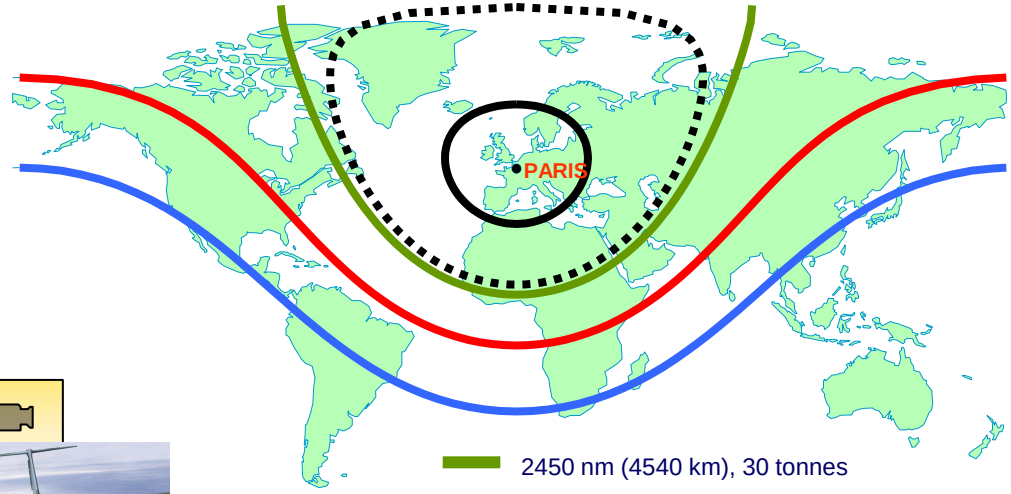
2 x ASLAV-25

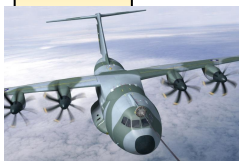


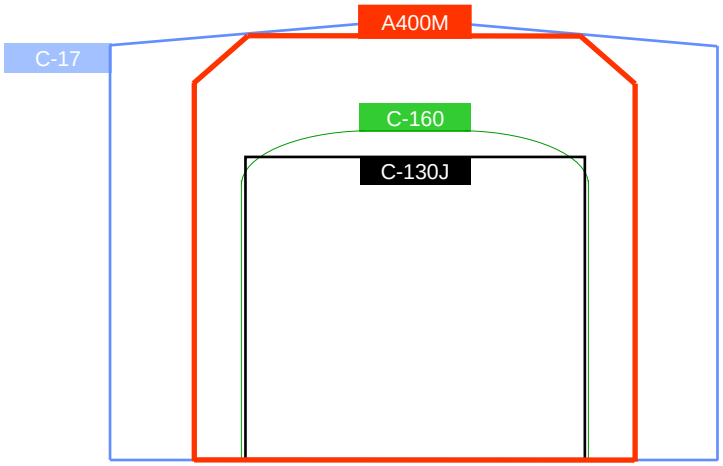
NH90



2 x Eurocopter Tiger







THE AIRBUS AIRCRAFTS

- A very significant in service experience (31/08/2011)

	A300 - A310 - A300/600	A320 Family	A340 / A330	A380
Flight Hours	33.1 10^6	105.7 10^6	40,2 10^6	0.38 10^6
Average flight duration	2	1,8	5,33	8.04
Number of cycles	16,6 10^6	58.7 10^6	7.5 10^6	47 335

THE SPECIFIC AIRCRAFTS

- THE ACJ OR “ELITE” RANGE

THE SPECIFIC AIRCRAFTS

- THE MRTT (Multi Role Transport Tanker)

-A310

-A330

ROYAL AIR FORCE

14 FSTA

11 MRTT

AIRBUS
AN EADS COMPANY