ERT*ERTS 20*

A Perspective on Embedded Real Time Software in Commercial Aviation

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Summary

1 Commercial Aviation context and trends

Commercial Aviation context and trends

3.6 Billion pax

51.2 million tonnes of Fret

$2.7 Trillion GDP

Source: ATAG 2018

Commercial Aviation context and trends

A GROWTH MARKET

4% per year

more than double since 2001

BUT…

- Strong exposure to « plane bashing » because of perceived impact on global warming, noise, social cleavage
- Strong correlation to economic growth now impacted by trade war
- Very large order books for single aisle aircraft with signs of market softening in terms of net orders and large aircraft
- Growth pulled by Asia and low-cost

2 Ambition & challenges ahead

Ambition & challenges ahead

Aviation Industry goal to become CO^2 neutral despite growth

European Union Flightpath 2050

ref Y2000

-75%	-90%	-65%
CO^2	NOX	NOISE

Strong Inertia to introduce new technologies

Aircraft last 30 years	**Certification Rules are lengthy & conservative**	**Many Stakeholders**

Increasing complexity

Challenges related to Aircraft lifecycles

- Software cycle: **6 to 12 months**

- Hardware cycle: **3 to 5 years**

- A/C upgrades: **6 to 15 years**

- A/C production: **30 to 50 years**

- **30 years ago** the **A320 first Fly By Wire airliner still alive and kicking!**
- **30 years from now…2050!**

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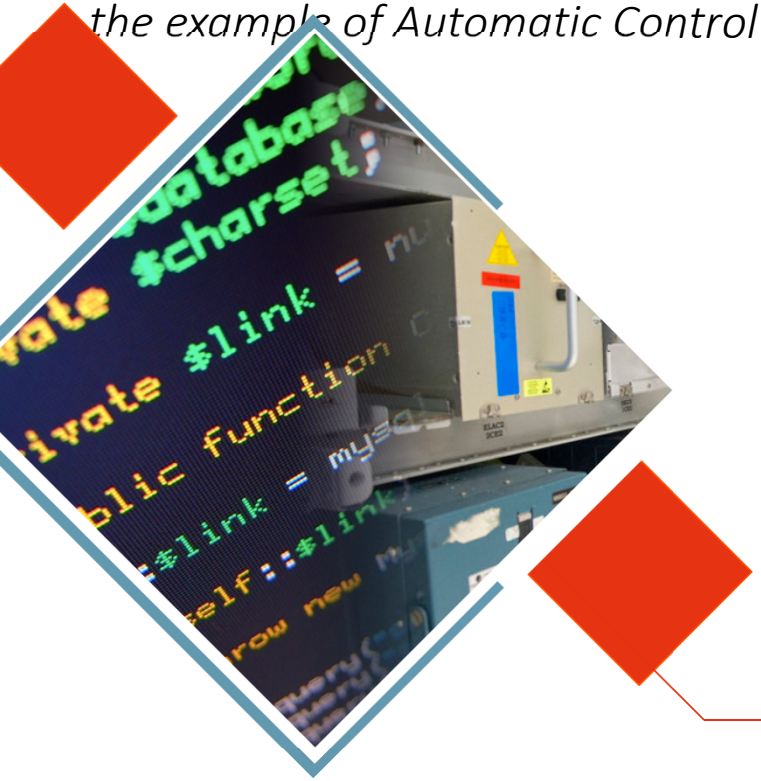
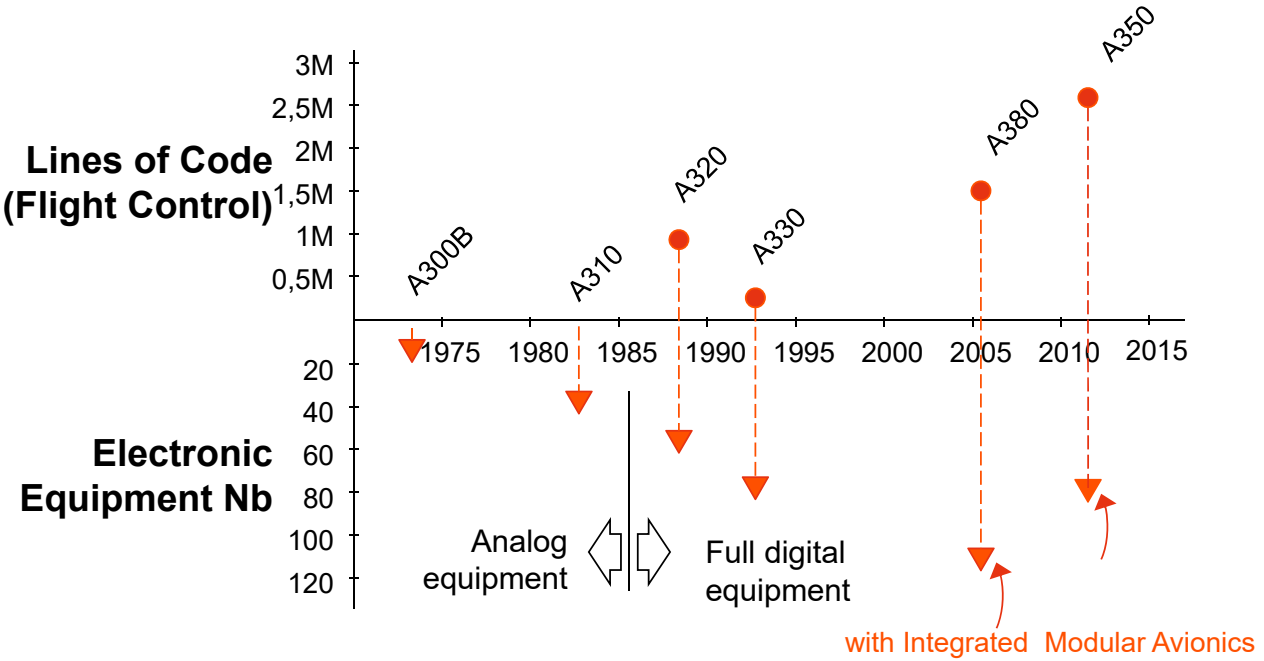
Challenges related to Increasing Complexity:

the example of Automatic Control





- Managing Complexity needs a Paradigm Shift :
  Architecture, Agile Methods, Artificial Intelligence…
  and Certification rules

3 A Roadmap shared by all Actors

A Roadmap shared by all Actors

Improve current platforms	▪ Safety Security Performance Costs
Improve current operations	▪ Industry Airlines ATM Airports
Prepare technological ruptures	▪ Alternative to Kerosene
Develop and implement new Methods, Tools, Way of Working	▪ Multi Disciplinary Optimization, Model Based Systems Engineering, Simulation, Digital Continuity, Configuration Management…
Leverage technological developments from other Industries	▪ e.g. Automotive
Leverage Numerical transformation	▪ Sensors, Data, Data Analytics, Artificial Intelligence, Cognitive sciences…

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Enhance existing platforms & preparing for new configurations

- New Engines on existing products
- Advanced composites
- Additive Layer Manufacturing
- Predictive maintenance

On the track of improving

- More Electrical Aircraft
- Laminar flow
- Flightpath Optimisation

Through better integration & architecture

- Boundary Layer Ingestion
- Open Rotor
- Distributed propulsion
- Hybrid propulsion
- Formation Flight

Towards new configurations & Urban Air Mobility

4 KEY CHALLENGES for ERTS

1st Challenge : How to share Data and where to locate decision making?

Commercial Aviation is a System of Systems :

Airlines - ATM Air Traffic Management - Airports - Aircraft Manufacturers – Engine and OEMs – MROs Maintenance, Repair & Overhaul...

- What Decisions shall be made at Aircraft level?

- What Data is required at Aircraft level?

This is key to define ERTS strategy both for specifying the next generations and enhancing existing products

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2nd Challenge : Add value at Aircraft level

Time to decide drives the required performance for embedded systems:

- Aviate/Fly Safety/Efficiency Seconds / Minutes Resilience to multiple failures
- Navigate Safety/Efficiency Minutes Diversion/Rerouting/ATM4D
- Communicate Efficiency/Reliability Minutes/Hours Diagnosis/Actions

Data is key:

Moving from a traditional ATA approach to a Data centric approach at Aircraft level thus allowing to define the sensors architecture.

Conversely Resilience to Data e.g. sensor failure, voluntary corruption of data is of the essence: security – detection - reconfiguration

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3rd Challenge : What will the role of Human be?

From enhancing human capabilities to full autonomy...

2 Key aspects :

Certification

Towards non deterministic approaches and self learning systems which require much faster feedback loops from operations across the fleet(s)

Human Centric Design

Moving from classical senses HMI towards cognitive neurosciences e.g. workload/stress, situation awareness and reaction to signals

Concrete application: Single Pilot Operations

4th Challenge : Time is of the Essence

Next Generation of Real Time embedded Software is an exciting challenge...

Yet a New Aircraft launched today will only start to have an impact 20 years from now!

So enhancing Current Fleets of Arcraft is of the essence to

- **Improve Safety**
- **Minimize Environmental Impact of Aviation**
- **Improve overall efficiency**

This is also what Embedded Real Time Software is about!