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## Flying Embedded Software Challenges in Aeronautics

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### Flying Embedded, outline

- Dimensions of Software Intensive Systems in Civil Aeronautics
- Vision and Challenges for the Next Generation
- The Value of ITEA2



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## Dimensions of Software Intensive Systems in Civil Aeronautics

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## The Airbus Family Concept

**15** *models*  
**6,507** *aircraft sold to*  
**236** *customers*  
*(as of 31<sup>st</sup> August 2006)*

**An Integrated Family  
with Systems enabled  
Operational Commonality**

**4,413 delivered**  
**283 2006 deliveries**  
*(as of 31<sup>st</sup> August 2006)*

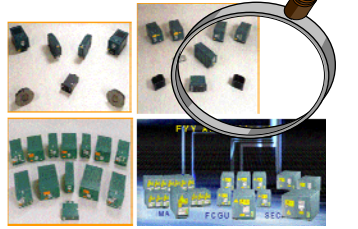
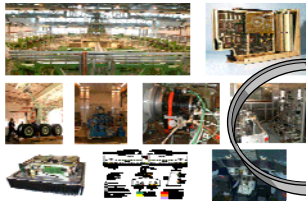
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# The Economic Dimension of Software Intensive Systems



**Systems represent about 30% of the Aircraft price**

- 100 Million lines of SW code
- Tens of Millions of work hours
- 100€NRC per single line of certified level-A SW code

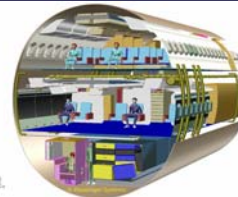
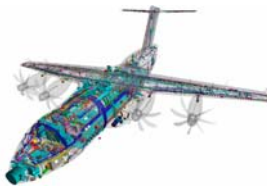


**Embedded Systems represent about 40% of the Systems price**

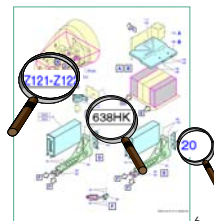
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# Scope of Applications for Software Intensive Systems



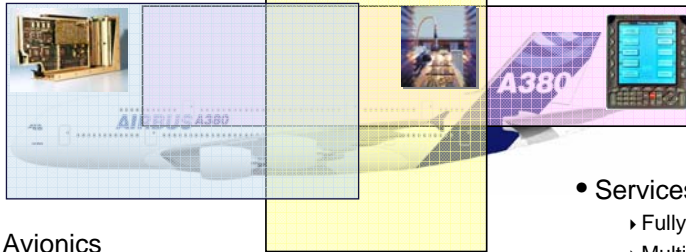
- Avionics
- Cabin and cargo systems
- Information management platforms
- SW based airline services
- Simulation products



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# Characteristics of the Main Classes of Software Intensive Systems



## • Avionics

- Functionally complex
- Open architecture
- Safety critical
- Long lead time
- Long life cycle
- Expensive
- Narrow low pace market
- Focused supply chain

## • Communication and information

- Fully interoperable
- Open world
- Security critical
- Short lead time
- Shorter life cycle
- Part of a broad and fast evolving market
- Volatile supply chain

## • Services

- Fully customisable
- Multi source solutions
- Security critical
- Short lead time
- Shorter life cycle
- Narrow market
- Complex industrial landscape

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# Illustration of Airbus Avionics Products



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## Vision and Challenges for the Next Generation



## A Product Vision for Software Intensive Systems

- Software Intensive Systems and Services shall be key **Enabling and Differentiating** elements for the next aircraft generation.
- Safety Critical Software shall be transparently enabling the aircraft operation, i.e. fully and permanently functionally **Available and Safe**.
- Services shall have high **Operational Added Value**:
  - ▶ with revenue generation capabilities for the airlines
  - ▶ extremely customisable
  - ▶ with high potential of evolution over the aircraft life cycle (30 years).



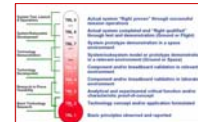
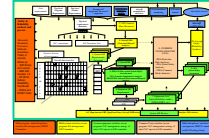
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## Top Challenges for Software Intensive Systems in Civil Aeronautics 2/2

- Maintain the same very high level of **Security & Safety**, as achieved today, but with increasing functionality, and prove it.
- Assure very high level of **Maturity** at entry into service:
  - › in spite of sophisticated industrialisation processes
  - › for a widely distributed supply chain
- Reduce **Cost of Development** of certified software, in terms of:
  - › lead time and cost of the nominal design cycle
  - › effort and time required for re-validation and re-certification after modification



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## Technology Breakthroughs

- The next **Breakthroughs in Software Development** are expected from Verification Processes, Methods and Tools:
  - › Model Driven Approaches,
  - › Formal Methods such as Static Analysis for Software verification
  - › Automatic Code Generation
- Other improvement axes:
  - › Standardisation
  - › Fast prototyping
  - › Composition, Incremental Design and Certification



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## Business and Supply Chain Evolutions

- Expected evolutions in the economics of software:
  - ▶ emergence of start-up companies and SME's that will ensure **industrialisation** of advanced software tool prototypes available in the European research environment in a short time to market
  - ▶ development of the **Open Source** approach, as the only realistic way to reduce costs and to rise the sustainability of the software development tools.



- Issues:
  - ▶ The tool market for Software Intensive Systems design in civil aeronautics is a niche market.
  - ▶ The required level of quality of these tools induces high costs.
  - ▶ Innovation can only be boosted in an industrial environment that goes beyond aeronautics in terms of **infrastructure and investment**



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## The Value of ITEA2



INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT



## The Value of a European Approach in Software Intensive Systems

- Innovation in Software Intensive Systems ...

- ▶ ... is only sustainable if addressed at the European level, from both the technological and methodological point of views
- ▶ ... must be leveraged by exploiting European vertical industry-SMEs and horizontal cross-sectorial synergies



- The European Research environment ...

- ▶ ... is globally favourable, thanks to the decisive support of National and European initiatives
- ▶ ... is rich of academic and research skills, though still fragmented into multiple research infrastructures



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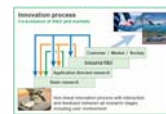


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## The Value of ITEA2

- Vision and road mapping:

- ▶ visionary planning and rigorous road mapping capability
- ▶ efficient technology acquisition processes, through focussed projects and lean management



- National insights:

- ▶ improving coordination across national authorities, but still some difficulties in the completion of the funding cases



- ITEA2 beyond technology, towards innovation:

- ▶ to sustain the consolidation of the European business environment and research infrastructure
- ▶ to support pre-competitive projects for tools industrialisation
- ▶ to increase support to the Open Source approach
- ▶ to encourage cross-industrial fertilisation



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