Safety Assurance in Digital Safety Systems

From Airplanes to Atoms

Nuclear Regulatory Commission
Regulatory Information Conference
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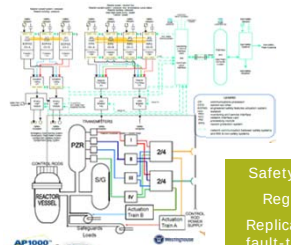
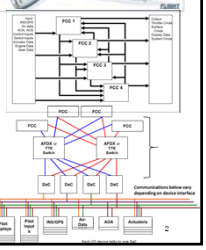
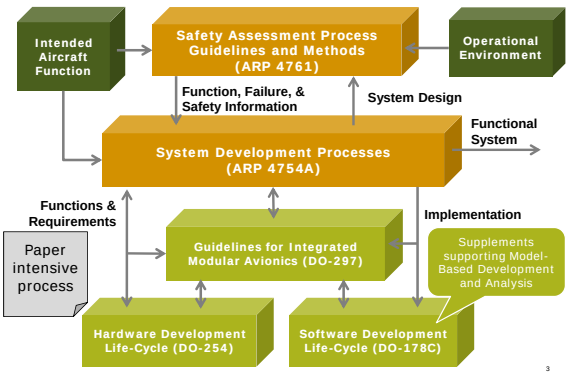
Similar concerns…





- Safety-critical
- Regulated
- Replication for fault-tolerance
- Software intensive
- ⬅ Fail-safe
- Fail-op ➡

Certification Process for Civil Aviation



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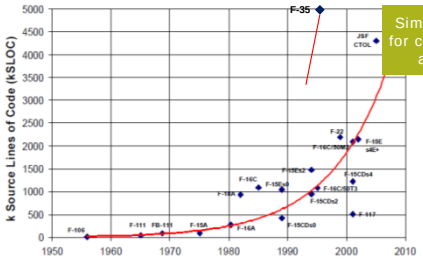
Software is growing!

"Software providing essential JSF capability has grown in size and complexity, and is taking longer to complete than expected," the GAO warned. **Pentagon: Trillion-Dollar Jet on Brink of Budgetary Disaster,** Wired 3/21/12



Similar curve for commercial aircraft

Source: D. Gary Van Oss (USAF), "Avionics Acquisition, Production, and Sustainment: Lessons Learned – The Hard Way," NDIA Systems Engineering Conference, Oct 2002.

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- Increased use of software in safety-critical functions
- Complexity of software
- Incorporation of COTS hardware/software
- New technologies that challenge the existing certification process
- Limitations of testing for safety assurance

What can NRC learn from civil aviation experience?

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Analytic Tools for Software Analysis

- Mathematical techniques for the specification, development, and verification of software aspects of digital systems
  - Formal logic, discrete mathematics, and computer-readable languages

Motivated by the expectation that, as in other engineering disciplines, performing appropriate mathematical analyses on software-based systems can contribute to establishing the correctness and robustness of a design

Analogy: FEA for structures

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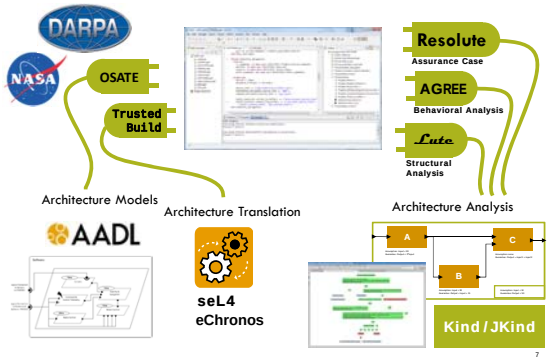
Research Results:
Mathematical Analysis Tools for Software-Based Systems



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Tools

- Model-Based Development tools have been **successfully adopted** by aviation industry for safety-critical software
- Analysis tools for software-based systems are **sufficiently mature** and capable to be applied to real projects
- Success at the software component (unit) level is being replicated at the system level to **manage complexity**
  - Verification of safety properties of system architecture
  - Assurance case integrated with system architecture model

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Certification

- Certification processes **change slowly**
  - Concerns of industry
  - Concerns of regulators
- Certification guidance for airborne software has been able to evolve to address **new technologies**
  - Joint effort of industry and regulators
- **Case studies** are helpful to bridge the gap between theory and practice
  - Pilot projects can help in the transition

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Cost matters

- Most defects occur in requirements/design phases
- Defects are more expensive to correct later in process
- Analysis tools can be used to **reduce costs**
  - Early detection/elimination of design defects
  - Automation of routine verification activities
- Multiple studies show good ROI

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