ARP-6983 and the challenges of ML implantation for avionic systems

Benjamin Lesage, Claire Pagetti, Nicolas Valot, Cédric Cazanove, Iryna De Albuquerque Silva, Adrien Gauffriau, and many contributors

More and more initiatives to integrate ML algorithms
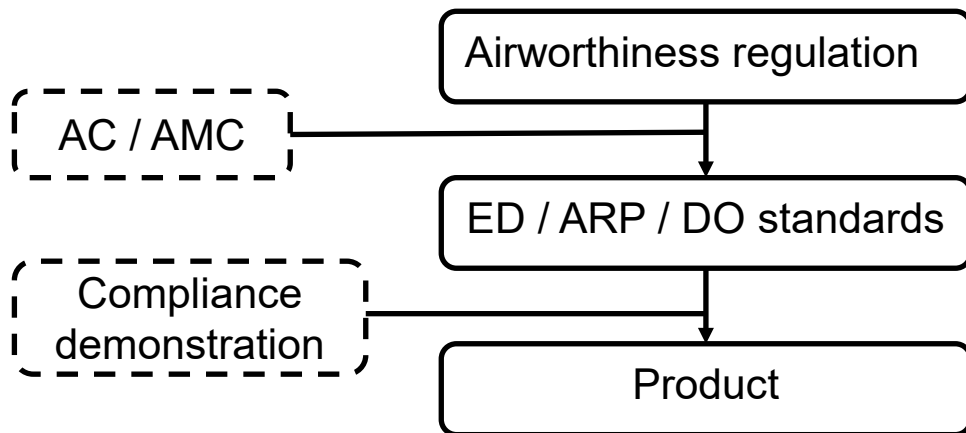
Example: Airbus project

- 2018 – 2020 ONERA contributor

- ATTOL (Autonomous Taxiing, Take-Off and Landing)

- See video

Copyright Airbus https://www.youtube.com/watch?v=9TIBeso4abU

How to safely integrate ML in avionics systems?

Certification requirements

Diagram:
- Airworthiness regulation → ED / ARP / DO standards → Product
- AC / AMC → (connects to ED / ARP / DO standards)
- Compliance demonstration → (connects to Product)

Legend:
- **EASA** European Union Aviation Safety Agency
- **FAA** Federal Aviation Administration
- **AMC** Acceptable Means of Compliance
- **AC** Advisory Circular
- **ARP** Aerospace Recommended Practices
- **DO** Design Organisation

- **Certification**: evaluation of an **argumentation**, to convince authorities that a system complies with the regulatory requirements
  - Accepted Mean of Compliance is to rely on **mature standards**
  - Applicants provide elements of the design, and Verification and Validation operations
  - If convinced, Certification authorities deliver a type certificate

Certification standards

DEVELOPMENT

DEPLOYMENT

ARP 4761 – Safety Assessment Process Guidelines and Methods

ARP 5150 – Safety Assessment of Aircraft in Commercial Service

ARP 4754B – Aircraft & System Development Processes

Operation

DO 254 – Electronic Hardware Development Life-Cycle

DO 178C – Software Development Life-Cycle

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Certification standards

DEVELOPMENT

ARP 4761 – Safety Assessment Process Guidelines and Methods

ARP 4754B – Aircraft & System Development Processes

DO 254 – Electronic Hardware Development Life-Cycle
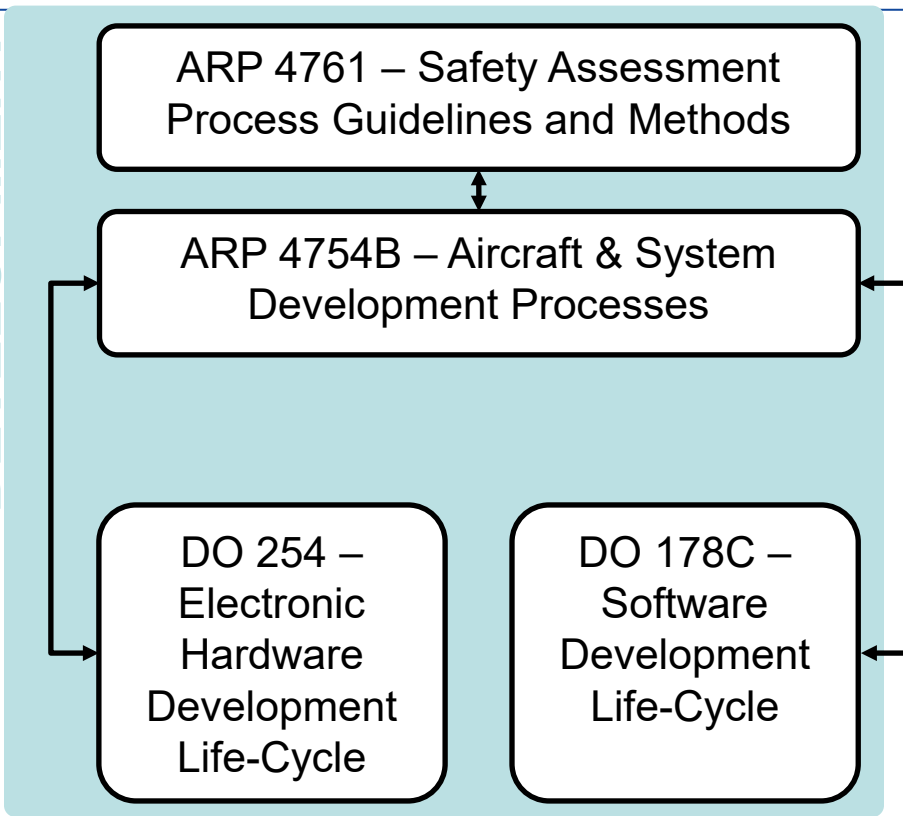
DO 178C – Software Development Life-Cycle

Existing standards are insufficient to cover ML-based system requirements

- Data-driven model development and training
- Gap between functional and low-level requirements
- Gap between ML model and deployed items

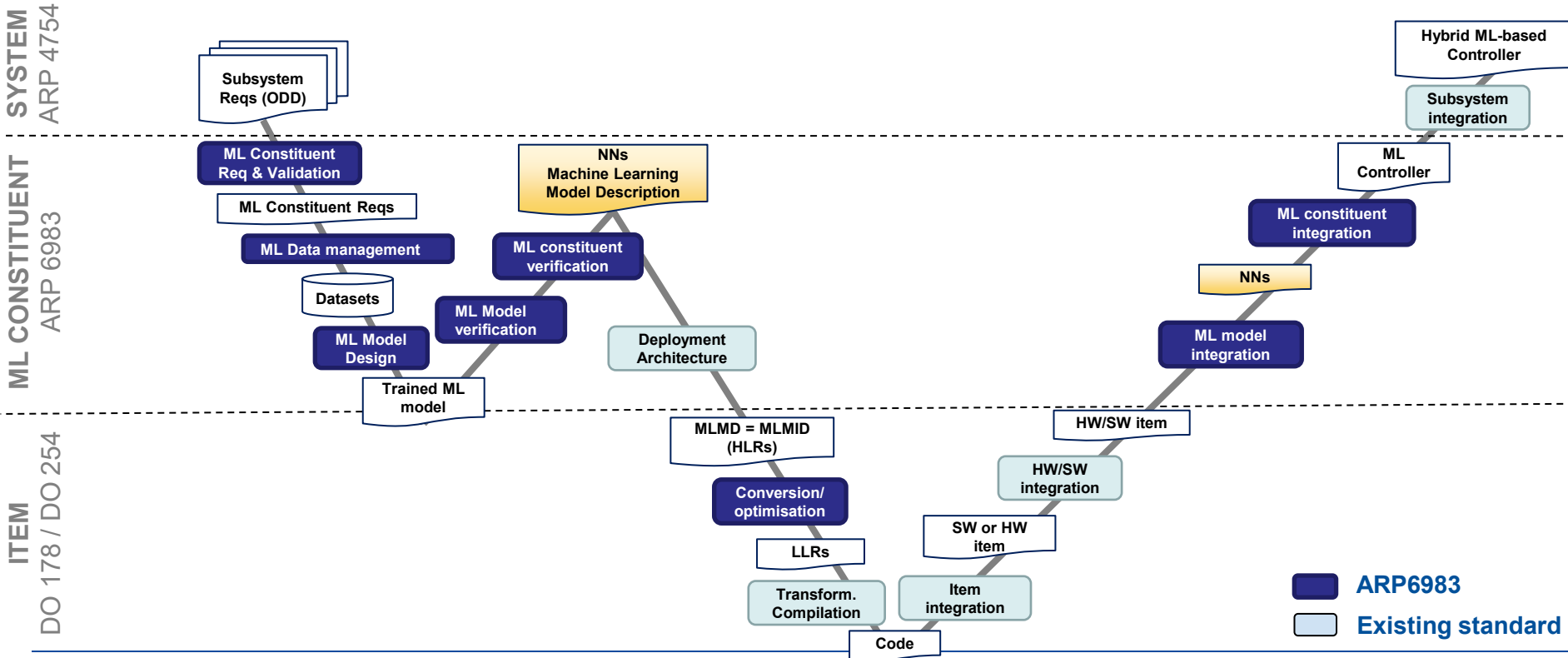# Certification standards – ARP 6983 / ED-324

DEVELOPMENT

ARP 4761 – Safety Assessment Process Guidelines and Methods

ARP 4754B – Aircraft & System Development Processes

ARP 6983

DO 254 – Electronic Hardware Development Life-Cycle

DO 178C – Software Development Life-Cycle
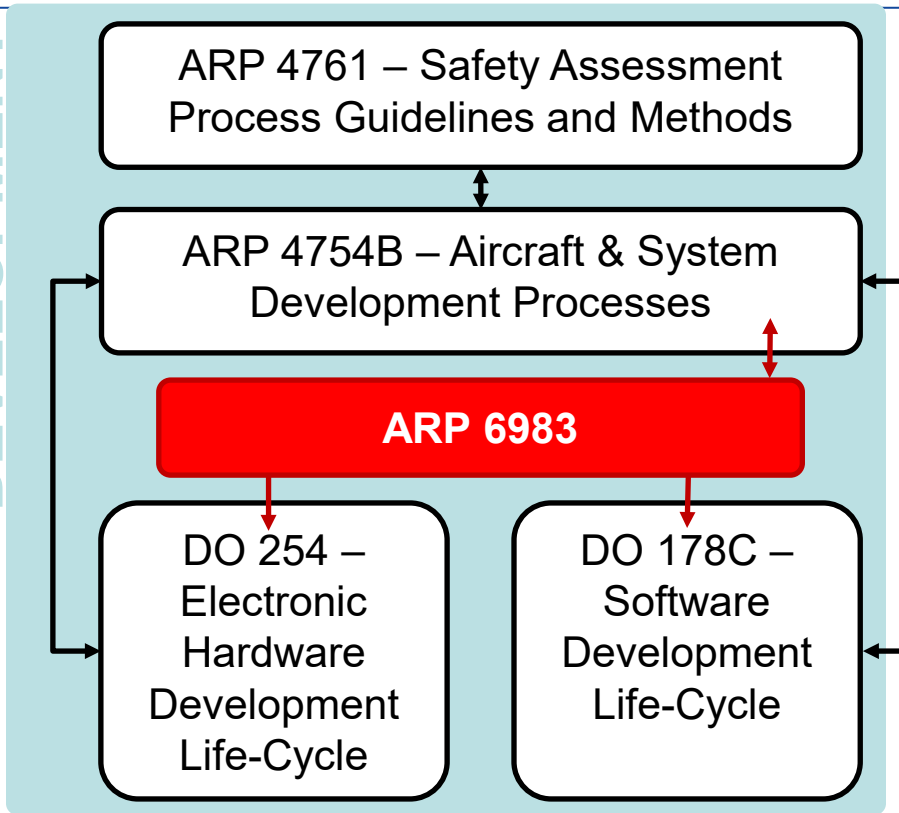
ARP 6983
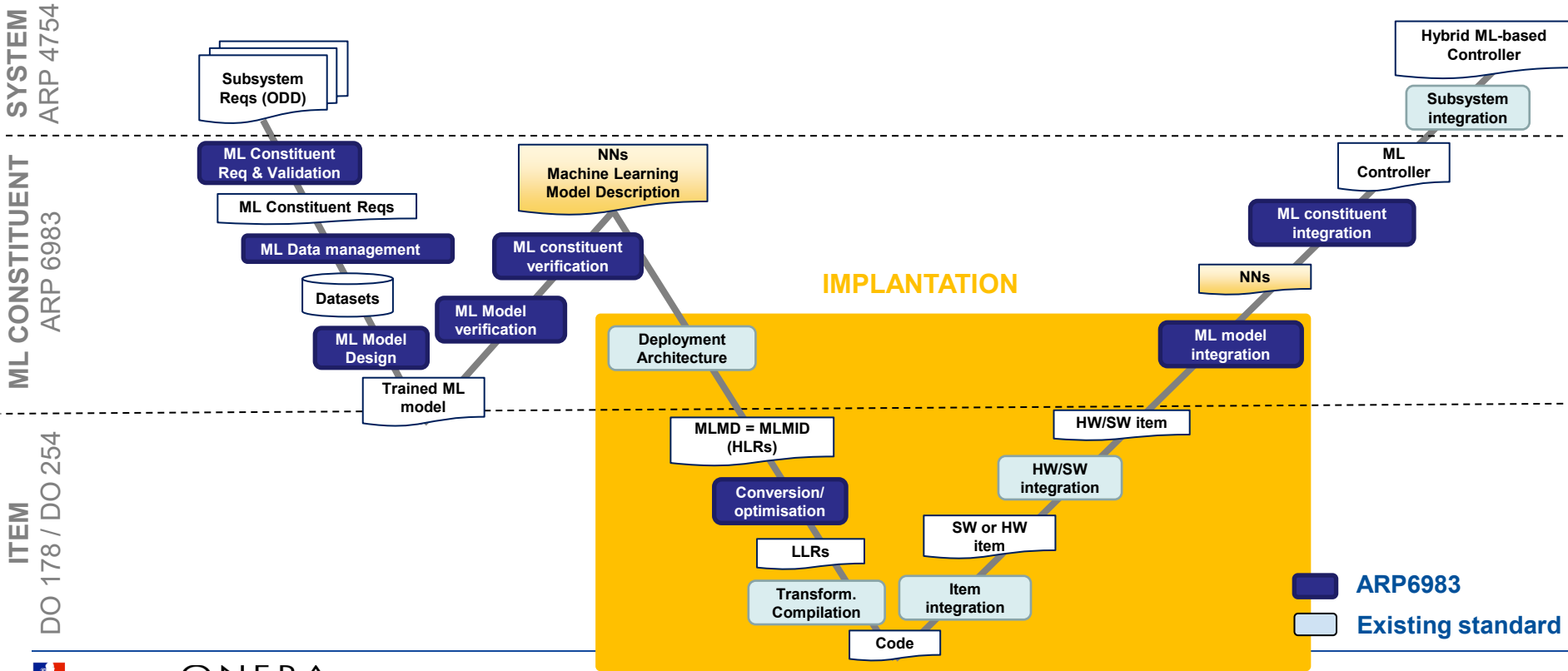**Process Standard for Development and Certification/Approval of Aeronautical Safety-Related Products Implementing ML**

- Draft from EUROCAE WG114 / SAE G34
- Capture new objectives and requirements
- References existing standards where relevant

EUROCAE

SAE INTERNATIONAL

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ARP 6983/ ED-327 standardized process

ARP 6983/ ED-327 standardized process

Implantation Challenges

- ## Challenges from a new class of algorithms
  - Higher-level task model for deployment

- ## Challenges from a new generation of hardware/software platforms
  - Higher computing demand calls for Heterogeneous COTS Edge devices
  - Higher computing demand calls for New computation paradigms

- ## Challenges from semantic preservation from the model to the items
  - Balance accuracy and performance on constrained devices
  - Traceability of decisions and transformations from model to implementation, e.g. quantization

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Conclusion - Old Standards, New Methods?

Do we need new methods to address ML requirements?

- Implantation refers mostly to existing standards and processes
  - New steps focus on the ML Model training and management

- There is a wealth of work in the real-time community
  - There are new challenges, and there are old ones
  - Existing scheduling, timing analysis, or compilation techniques should apply
  - Although there is always room for improvement

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Certification: some bibliography

- EASA
    - Artificial Intelligence Roadmap 2.0 – 2023
    - First usable guidance for Level 1 machine learning applications – 2021
    - First usable guidance for Level 2 machine learning applications – 2023
    - Guidance for Level 1 & 2 machine learning applications - 2024
- EUROCAE WG 114 / SAE G34
    - AIR 6988 Artificial Intelligence in Aeronautical Systems SoC (Statement of Concerns) – 2021
    - AIR 6994 Artificial Intelligence in Aeronautical Systems: Use Cases – 2022
    - ARP 6983 – draft
- ANITI/DEEL/IRT Saint Exupéry:
    - White paper Machine Learning in Certified Systems – 2021