



SAVOIR FDIR HANDBOOK

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DEFENCE AND SPACE

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Agenda

- Background, History and status
- Handbook overview
 - FDIR Engineering
 - FDIR Process
 - FDIR Documentation
- Conclusions and perspectives



Background, History and Status

It all started here...

ADCSS 2011 – FDIR Round Table

- Exchange about issues, shortcomings, challenges

ADCSS 2015 – FDIR Session

- Exchange about state-of-the-art practices...
- ...that lead to agree that:
 - Common terminology must be defined and used across industry
 - Processes must be further improved and consolidated, FDIR and V&V remain challenging
 - Gap between academic state-of-art and industrial state-of-practice shall be reduced

Need to establish a community
Need to establish a common goal

→ ***SAVOIR FDIR HANDBOOK***



SAVOIR FDIR Handbook

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Background, History and Status

...step by step it grew...

- 02/03/2016: ESA Internal Kick-Off
 - 11 members covering different disciplines (SW, PA/RAMS, AOCS/GNC, Payload)
 - 8 Working Meetings
- 04/08/2016: First draft of the Handbook
 - Inspired by NASA-HDBK-1002 (Draft, 2012)
 - Based on inputs from completed and on-going TRP and GSTP studies
 - Illustrated with experiences from ESA missions (specs, best practices, lessons learned)
- 12/2016: SAVOIR SAG agreed to establish a SAVOIR FDIR WORKING GROUP
- 19/01/2017: Terms of Reference (ToR) issued
- 01/02/2017: SAVOIR FDIR Working Group Kick-Off
 - 40+ participants, cross-disciplinary (FDIR, AOCS, SW, RAMS, PA, SYSTEM, ...)
- 2017-2018: SAVOIR FDIR Working Group Iterations
 - 10 active and productive Working Meetings (Face-to-face and / or teleconference)
 - Off-line work with many comments collected, various experiences captured from people with different backgrounds,
 - Complex activity, substantial effort from DEIMOS and ESA for consolidation
 - 22 versions of the FDIR Handbook were issued

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Background, History and Status ...and now finally PUBLISHED!

- Reference: SAVOIR-HB-003
- Issue: 2.0
- Date of issue: 01/11/2019

- Available on the European Space Software Repository
 - <https://essr.esa.int/project/savoir> (log in to essr.esa.int first!)
 - Note: distribution limited to *ESA member states only*

- Contact point: savoir@esa.int



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SAVOIR FDIR Handbook Overview

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SAVOIR FDIR Handbook Overview

3. OVERVIEW OF FDIR

- Main Pitfalls of FDIR Design & Development
- Introduction of FDIR Engineering, FDIR Engineer role and interactions with other disciplines
- FDIR Strategy guidelines
- FDIR Design principles: architecture, hierarchy / levels, implementation aspects, platform and payload FDIR management
- FDIR requirements

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4. FDIR PROCESS

Seven steps are identified

- Step 0: FDIR Requirements
- Step 1: FDIR Concept Definition
- Step 2: FDIR Architecture Design
- Step 3: FDIR Detailed Design
- Step 4: FDIR Implementation and Verification
- Step 5: FDIR Validation
- Step 6: FDIR in Operations (Preparation)

For each of them, the handbook describes in detail:

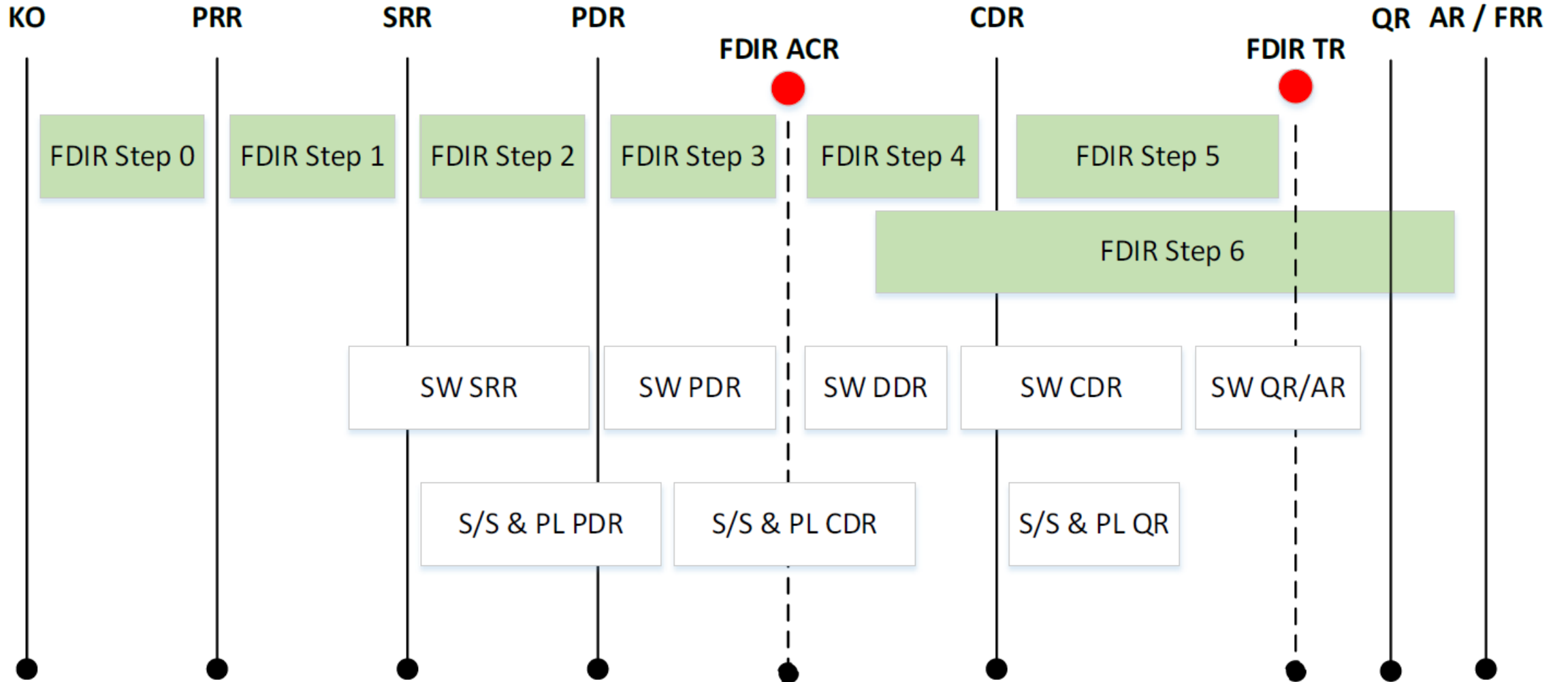
- the **objective** of each process step,
- the **programmatic dependencies** with the ECSS process steps,
- the required **inputs** (per discipline) that are needed to perform the process step,
- the expected **outputs** that are the result from this process step,
- a **description of the activities** performed to produce these artefacts,
- **guidelines and lessons learned** to assist in performing the process step effectively,
- and, finally, **resources** (i.e. methods, tools, techniques) that can be used to implement the activities efficiently.

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4. FDIR PROCESS



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4. FDIR PROCESS

Two major **FDIR reviews**, recommended to address the problems often seen in programs

FDIR Architectural Checkpoint Review (ACR) → Verify design maturity before System CDR

- All failure modes identified, agreed and addressed
- Failure Detection means defined and justified
- Failure Mitigation means defined and justified
- V&V Plan and requirements defined
- Compliance to System-level requirements verified (e.g. availability, timing, ...)

FDIR Tuning Review (TR) → Verify fitness for flight before System Q/AR

- Review the FDIR parameterization (fully defined, justified and verified) and its compatibility with system-level and mission design
- Ensure consistency of the FDIR in its entirety / avoid conflicts or interdependencies
- Consolidate all changes made during AIT, verification and validation, ensuring that all V&V steps are taken
- Complements the NCR/NRB process flow

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APPENDIX C – FDIR REPORT DRD

- The ***FDIR Report*** is the document that describes and justifies the concepts and the design of the Failure Detection, Isolation and Recovery, implemented either in space (on-board the satellite) and/or ground (operational procedures) segments.
- The ***FDIR Report*** as defined in this appendix, can be split into several documents if deemed more appropriate regarding configuration management along the project lifecycle.
- In particular the following main sections can be subject to dedicated document:
 - FDIR Analysis, Concepts and Design Report
 - FDIR Implementation (and Justification) Report
 - FDIR Verification and Validation Plan
 - FDIR Space Segment User Manual (detailing Ground Monitoring and Ground Contingency Procedures)

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Conclusions

The SAVOIR FDIR Handbook is available!

- It provides a commonly agreed Terminology
- It introduces FDIR Engineering (Design, Development & Verification) and the FDIR Engineer role
- It details a commonly agreed Process with inputs / outputs, activities, resources and mapped to ECSS-M-ST-10 life-cycle
- It provides Design considerations, lessons learned and guidelines (e.g. architecture, levels)
- It proposes an associated DRL/DRD
- It gives the relationships with ECSS Standards

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Perspectives

Use and promote the FDIR Handbook!

- Provide feedback (savoir@esa.int)
- Space Industry: use as guideline and reference
- Agencies: consider in proposals e.g. DRL/DRD and project reviews
- Other WG: take advantage of the FDIR WG community

Keep the WG alive! Potential future directions?

- Address new technologies e.g. AI, Model-Based, Data-Centric, ...
- Re-inforce operational aspects ...and operator error handling
- Enhanced the lessons learned, in-orbit feedback
- Extend handbook beyond Avionics e.g. mechanical
- Improve V&V approach, particularly testing objectives
- Consider missions classes, classes of FDIR requirements, qualitative vs quantitative
- Share and consolidate with international partners (e.g. NASA / JAXA)
- Transfer SAVOIR HB into ECCS artefact (TM, HB or full standard)

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Many thanks to the FDIR working group members!

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Thank You!

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