SAVOIR FDIR WORKING GROUP

Alvaro Martinez Barrio, Murray Kerr, Marcel Verhoef

17/10/2017

Agenda

- ❑ Background

- ❑ Internal ESA Working group

- ❑ SAVOIR involvement – Terms of References

- ❑ SAVOIR FDIR Working Group

- ❑ Status of SAVOIR FDIR Handbook

- ❑ Conclusions

European Space Agency

Background

❑ Since several years the topic of FDIR has been discussed in may occasions:

❑ ADCSS 2011. Outcome of the FDIR Session:

- o Lack of systematic approach, engineering transparency and guidance of the FDIR engineering process

❑ ADCSS 2015. Outcome of the FDIR Session:

- o There is a need for a common terminology and process.
- o FDIR definition (scope of impact) and V&V (size of problem space) remain challenging
- o Gap between academic state-of-art and industrial state-of-practice
- o The adoption of new technology remains difficult

ESA Internal Working Group

❑ As a result, it was agreed to stablish an ESA Internal FDIR Working Group with the final target to complete an FDIR Handbook.

❑ ESA Internal FDIR Working Group was kicked-off in **March 2016**, with 11 members covering different disciplines (software, PA, AOCS/GNC, payload)

❑ The inputs used for the handbook were:

- o Results from completed TRP and GSTP studies:
  - • COMPASS, VERIFIM, AUTOGEF, FOREVER, HASDEL, FAME, FDI-AOCS
- o Currently on-going studies (GAFE, CSSP, CATSY)
- o Experiences from ESA missions (specs, best practices, lessons learned)
- o Other resources: NASA (draft HDBK-1002), CNES

European Space Agency

First Draft of ESA Internal FDIR HB

- By **December 2016**, a first draft of the ESA Internal FDIR HB was completed:
  - Terms and Definitions
  - FDIR in ECSS standards:
    - Identification of where FDIR was currently referenced in ECSS, consistency of Terminology
  - FDIR process:
    - Mission phases and modes
    - FDIR V&V process
  - FDIR guidelines:
    - Strategy and scope
    - FDIR architectural principles (hierarchy, levels)
  - FDIR modeling and analysis / tools

European Space Agency

SAVOIR Involvement

❑ Progress on ESA Internal FDIR HB was reported to SAVOIR Advisory Group (SAG)

❑ SAG agreed to establish a SAVOIR FDIR WORKING GROUP targeting to produce a handbook (hopefully in one year time), published under the SAVOIR documentation tree (SAVOIR-HB-003), including recommendations and best practices to solve the issues found in ESA projects.

❑ Confirmed participation from TAS, ADS, OHB, CNES and DLR.

❑ On **19th Jan 2017**, the SAVOIR Advisory Group issued the Terms of Reference (ToR) for the elaboration of a handbook related to FDIR in the context of the SAVOIR initiative.

European Space Agency

SAVOIR FDIR – Terms of Rerences (1)

❑ Major issues identified:

- o FDIR is not treated as a "sub-system"
- o No commonly established FDIR Development Process
- o No agreed methodology
- o No systematic problem domain analysis
- o Usually follows bottom-up approach
- o Initiated (too) late in System Development
- o Complexity usually converges in SW and AOCS
- o Solution domain difficult to assess for completeness, adequacy

European Space Agency

SAVOIR FDIR – Terms of Reference (2)

❑ Goals to improve situation:

- o Fit-for-purpose FDIR
- o **Coherent, repeatable Process and Methodology**
- o Applicable from early Software and System architectural design
- o Coherent with System development lifecycle
- o Milestones with measurable FDIR maturity
- o Oriented towards Mission and System RAMS requirements
- o Advanced modelling and analysis techniques
- o Specification of nominal, erroneous, FDIR behavior
- o Automated FTA, FMECA, Failure Propagation and FDIR Analyses
- o Reference FDIR architecture
- o Foundations for Failure and Anomaly Management Engineering

European Space Agency

SAVOIR FDIR Working Group (39) participants

ESA:

Marcel Verhoef (co-convener)

Alvaro Martinez Barrio (co-convener)

Ana Rugina

Andrea Accomazzo

Andrei Oganessian

Antonio Harrison Sanchez

Benedicte Girouart

David Jameux

Giorgio Magistrati

Guillermo Ortega

Jean-Loup Terraillon

Luca Bolognino

Manrico Fedi Casas

Yuri Yushtein

Jesus Gil Fernandez

Fulvio Capogna

ADS: Gunther Lauthenschlaeger, Dave Thomas (lead), Ilario Cantiello, Jean-Paul Blanquart, Patrick Bergner

OHB: Massimo Tipaldi (lead), Hong-Joon Chun, Gordon Machel, Matthias Hoping

TAS: Regis de Ferluc, Brice Dellandrea, Antoine Provost-Grellier (lead), Gianluca Aranci, Luigi Galvagni, Philippe Fourtier

RUAG: Torbjorn Hult

CNES: Christian Pouliquen

DLR: Catherin Hobbie, Sascha Mueller

DEIMOS: Paulo Rosa, Murray Kerr (lead), Miguel Hagenfeldt

European Space Agency

SAVOIR FDIR Working Group organization (1)

- ❑ Challenges:
    - o Many participants and with different backgrounds
    - o Challenging target planning.
    - o A lot of elements in the scope of the ToR
    - o Activity is internally funded by all participants themselves
- ❑ Decision to follow an "agile" (iterative) development approach:
    - o Select a (few) specific aspect (s) of the problem domain
    - o Everyone focuses only on these aspect during the iterations
    - o Inputs from agreed actions due one week before plenary discussion(s)
    - o Discussion / consolidation via joint meeting (webex)
    - o Evaluate process, prioritize and update for next iteration
- ❑ Proposed Webex meeting schedule: once per month (half day)
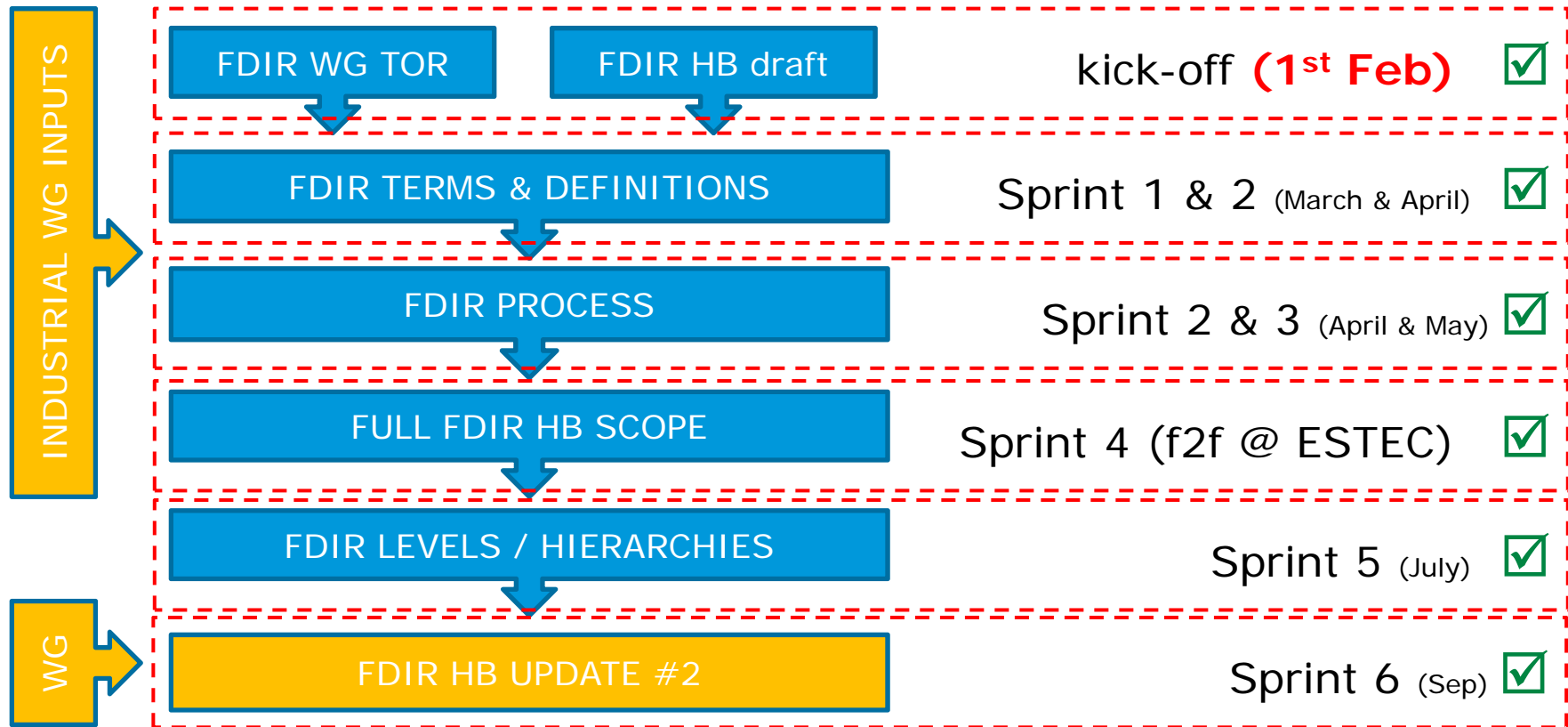- ❑ Small support contract with DEIMOS, to support editing/managing of the HB

European Space Agency

SAVOIR FDIR Working Group organization (2)

❑ An alfresco site has been set up to exchange information among participants.

❑ Sixteen working group meetings held to date (8 internal ESA, 8 with full WG)

❑ The first meetings were focusing mainly on exchange of information and alignment of the terms and definitions.

❑ On June, a 2-days workshop was held in ESTEC, with the objectives of
   o Ensuring all topics of the draft FDIR HB had been covered at least once.
   o Harmonize and consolidate viewpoints wherever possible.
   o To ensure that the scope of the HB was agreed
   o To provide sufficient information to create a significant HB

❑ Two major updates have been done to the FDIR Handbook

❑ Working group has provided comments to these updates and they are currently being implemented for next internal release (10th of November)

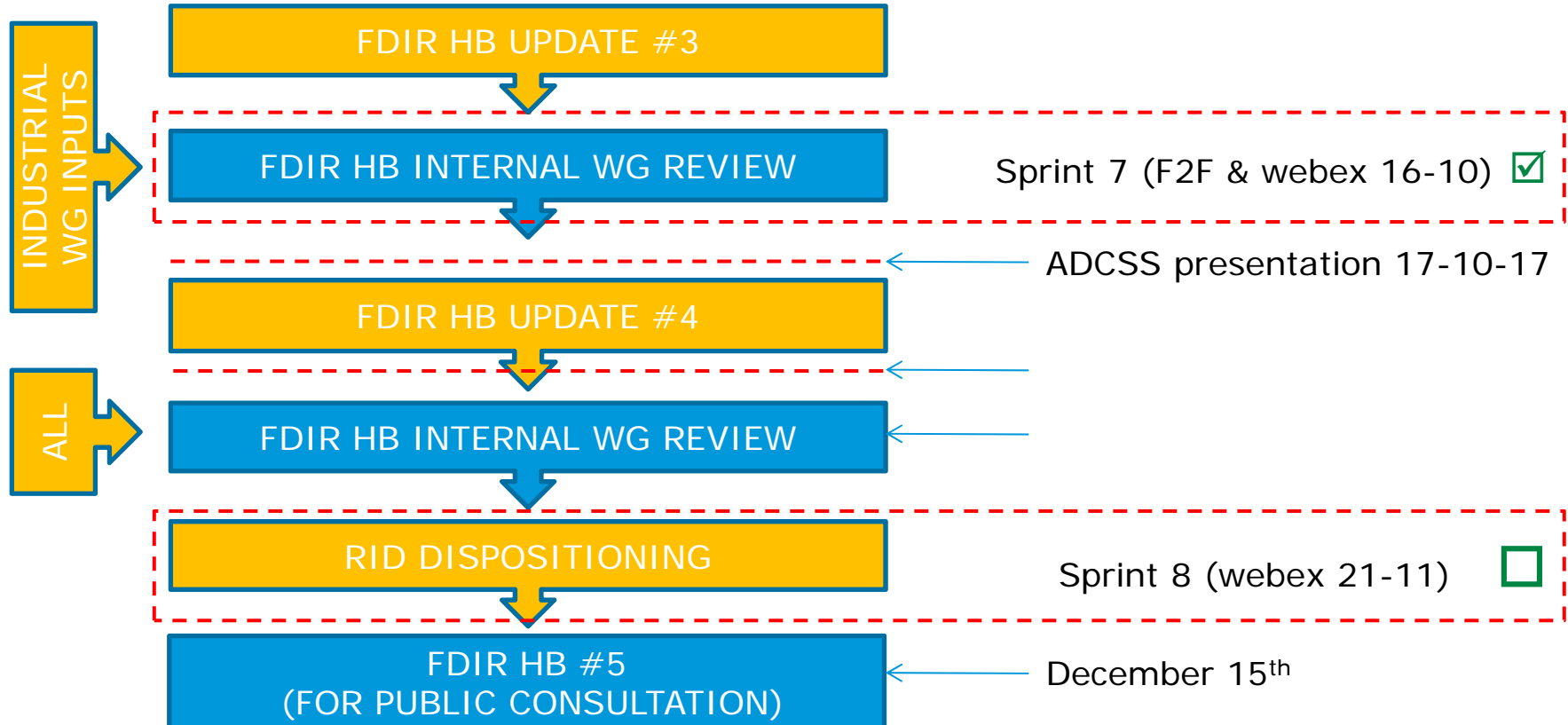❑ Objective is to have a consolidated HB for public consultation by 15th December 2017

SAVOIR FDIR Workshop – June 2017

European Space Agency

Working group – "agile process" (1)

INDUSTRIAL WG INPUTS	FDIR WG TOR FDIR HB draft	kick-off **(1ˢᵗ Feb)** ☑
	FDIR TERMS & DEFINITIONS	Sprint 1 & 2 (March & April) ☑
	FDIR PROCESS	Sprint 2 & 3 (April & May) ☑
	FULL FDIR HB SCOPE	Sprint 4 (f2f @ ESTEC) ☑
	FDIR LEVELS / HIERARCHIES	Sprint 5 (July) ☑
WG	FDIR HB UPDATE #2	Sprint 6 (Sep) ☑

Working group – "agile process" (2)

ESA UNCLASSIFIED - For Official Use

SAVOIR FDIR Handbook Status (work on going)

❑ Main agreement has been made on the FDIR process and its relation to the normal phases of a space mission.

❑ WG has identified the need for additional FDIR milestones, as a recommendation to solve problems often seen in programs.

❑ The main focus is on "system" FDIR process, summarized in 6 steps:

- the *objective* of each process step,
- the *dependencies* with the ECSS process steps,
- the required *inputs* 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.

To be agreed
Work on progress

European Space Agency

SAVOIR FDIR Handbook Status (work on going)

❑ Relation of FDIR process with other ECSS documents is also treated in specific annexes

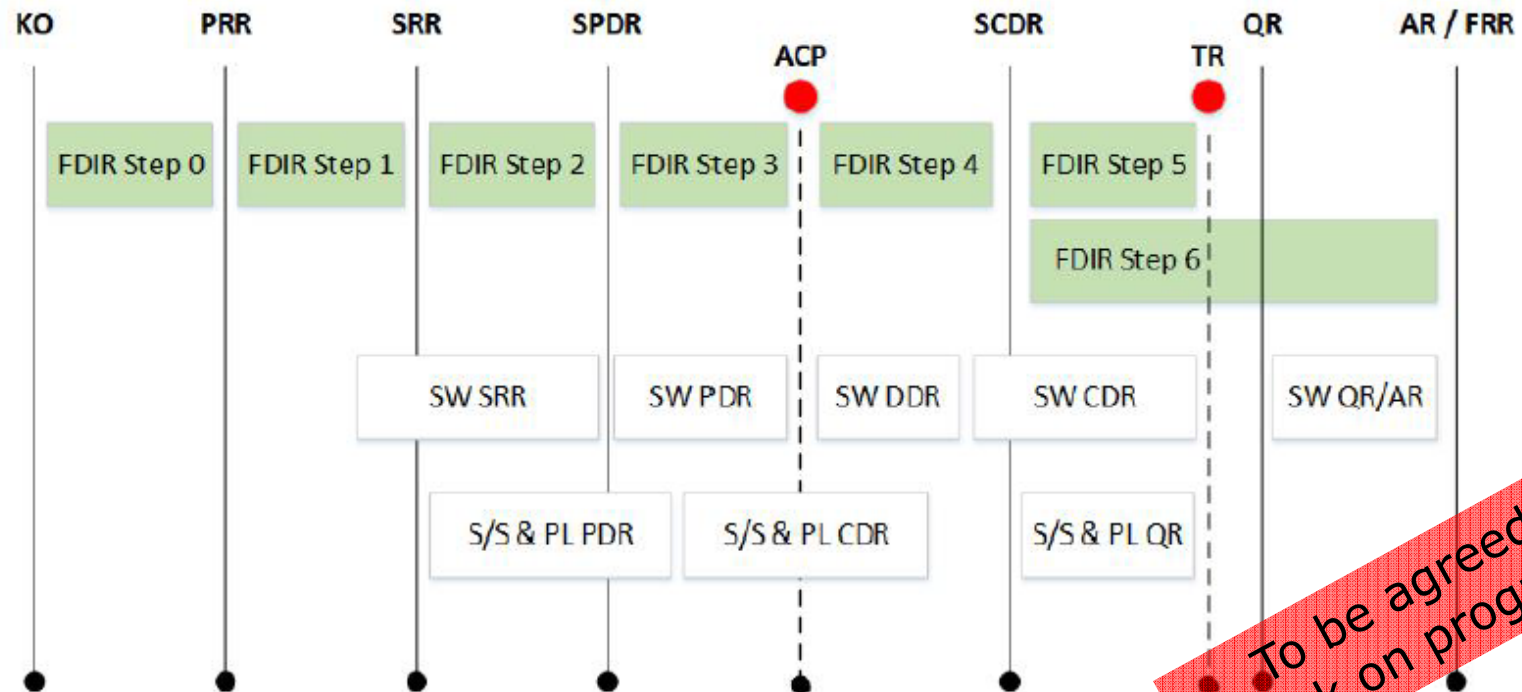❑ DRL and DRD will also be provided

To be agreed Work on progress

Figure 1 Illustration of the relationship between the FDIR process Steps defined in Chapter 3, the System milestones, and the S/S & PL and SW processes

SAVOIR FDIR HANDBOOK – FDIR process

Figure 2 Illustration of the link between the FDIR process steps and the project life cycle as, per ECSS-M-ST-10C

European Space Agency

Conclusions and way forward

❑ Despite very ambitious schedule, significant improvements have been made to the SAVOIR FDIR Handbook, but the work is still on progress.

❑ Participants of the working group has shown a very collaborative and open approach which is key for the fulfillment of the task.

❑ Good agreement has already been achieved on the overall process of FDIR.

❑ Work is still on progress for many other points, but we are confident to be able to deliver a consolidated version for public consultation by 15th of December 2017.

❑ We would like to thank all members of the working group for their support and contributions.

European Space Agency