15th ESA workshop on Avionics, Data, Control and Software Systems (ADCSS2021)

SAVOIR Status - FDIR Handbook V2

Silvana Radu (ESA)

Paulo Rosa (Deimos)
Denis Di Filippantonio (Deimos)

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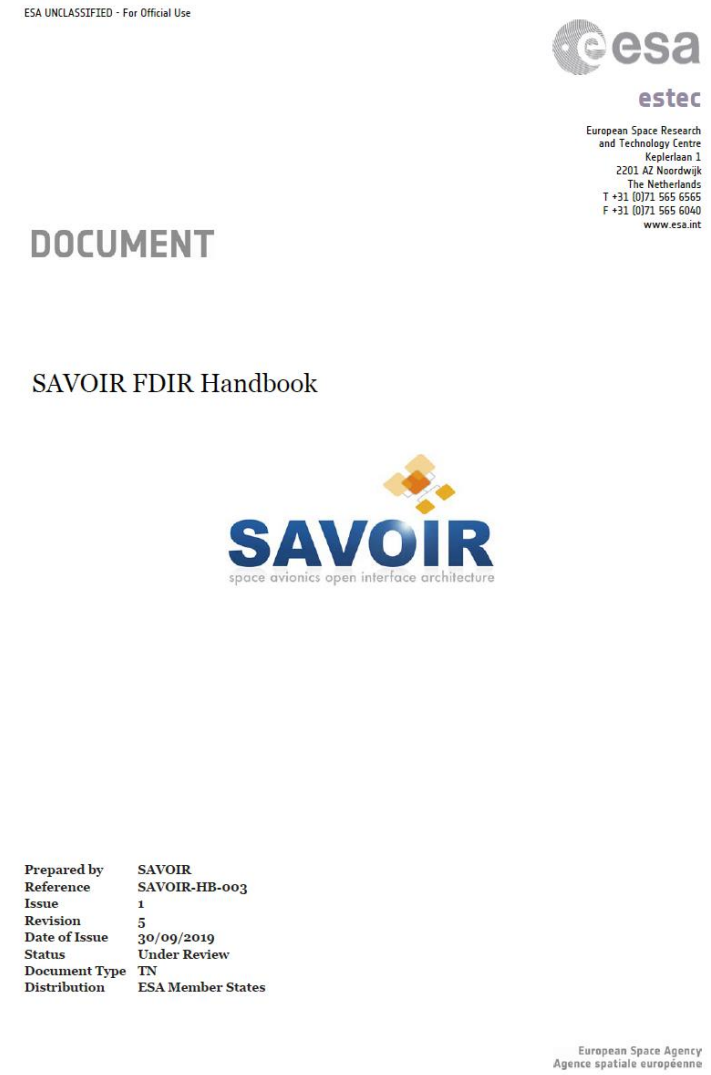
Content

1. Scope
2. Composition and support
3. Major topics under discussion
4. Planning and timeline
5. Lessons learned
6. Minor topics under discussion
7. Background activities
8. Meeting #2 outcomes
9. Way forward



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esa

estec

European Space Research
and Technology Centre
Keplerlaan 1
2201 AZ Noordwijk
The Netherlands
T +31 (0)71 565 6565
F +31 (0)71 565 6040
www.esa.int

DOCUMENT

SAVOIR FDIR Handbook

SAVOIR
space avionics open interface architecture

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1. Scope

- ✓ Identify missions or technologies for which common FDIR design and processes recommended in the first issue of the handbook are not applicable or require tailoring
- ✓ Identify minor aspects within the handbook that are needed for update in order to be aligned with other existing handbooks or technical notes
- ✓ Revise overall handbook and alignment with ECSS
- ✓ Gather lessons learned from satellite manufacturers and mission operators on FDIR and integrate those lessons learned in the handbook

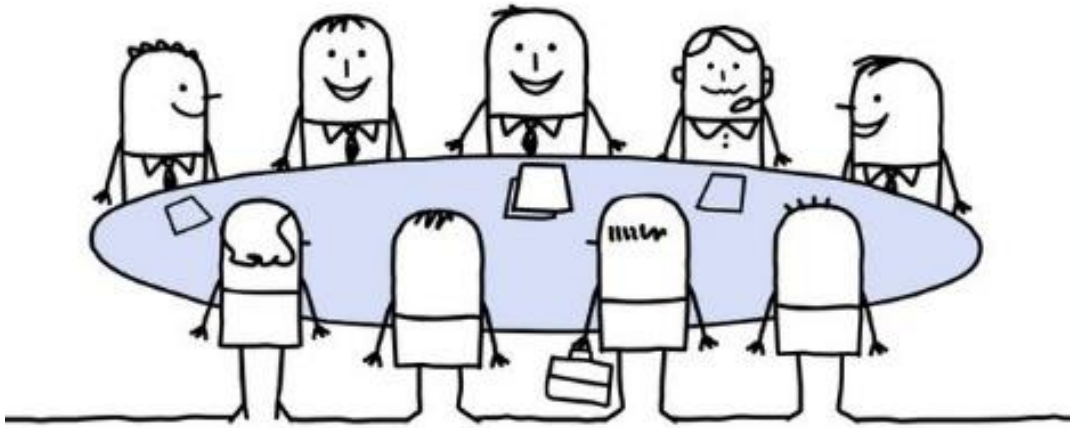
Ensure the handbook can be used for a large range of types of missions, including with regards to new niches such as Close Proximity Operations, high autonomy, use of AI/ML, etc.

- ✓ At the SAVOIR Advisory Group meeting #51, the SAG has decided to continue the FDIR working group for the elaboration of the second issue of the SAVIOIR FDIR.

2. Composition and support

From ESA side:

Name expert	Expertise
Andrei Oganessian	Avionics, SW
Andrew Brown	PA, RAMS
Andrew Wolahan	System, CPO
Benedicte Girouart	GNC, AOCS
Charles Lahorgue	Constellations, RAMS, FDIR
Cristophe Honvault	Software
Christoph Steiger/ Caglayan Guerbuez	Operations
David Pena Hidalgo	Software
Jean-Loup Terraillon	Savoir, MBSE
Laurent Hili	CDHS, AI/ML
Marcel Verhoef	MBSE, SW
Mauro Caleno	Software
Massimo Casasco/ David Sanchez	GNC, AOCS
Roger Walker/ delegated	CubeSats
Silvana Radu	RAMS, CPO, CubeSats, MC
Ferdinando Tonicello	Power



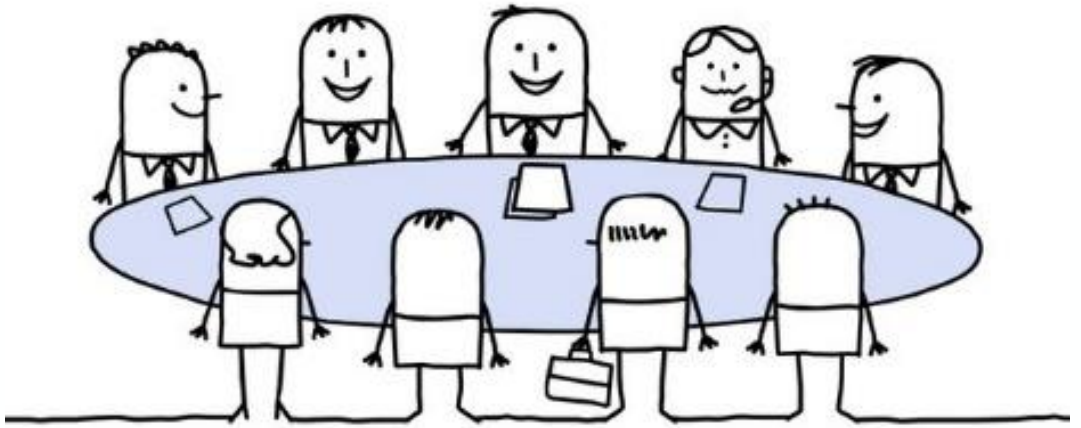
Co-chairs:

- Silvana Radu
- Benedicte Girouart

2. Composition and support

From industry side:

Name expert	Organisation
Dave Thomas	ADS
Stephanie Bourbouse	ADS
Nathalie Pons	CNES
Aurelie Strzepek	CNES
Lennart Andersson	RUAG
Olivier Rigaud	TAS
Orion Azzis	TAS
Stefano Di Vito	TAS
Matthias Hoping	OHB
Machel Gordon	OHB
Paulo Rosa	Deimos
Denis Di Filippantonio	Deimos



Support to ESA Co-chairs:

- Paulo Rosa
- Denis Di Filippantonio

2. Composition and support

Deimos main tasks:

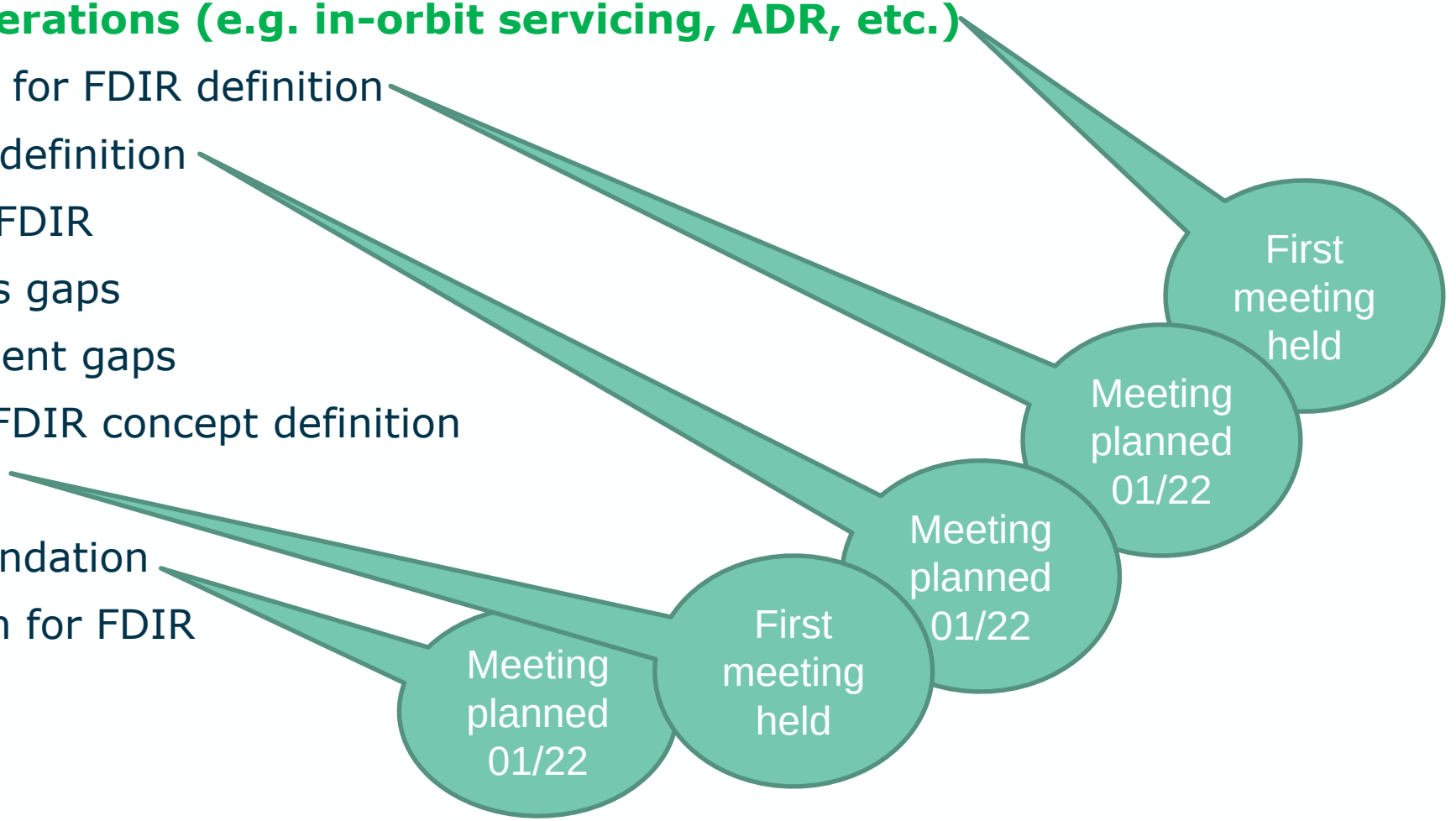
- Organise splinters
- Support convergence towards a consensus

- Maintain the shared repository
- Gather the lessons learned from industry
- Keep minutes of meetings
- Prepare status reports

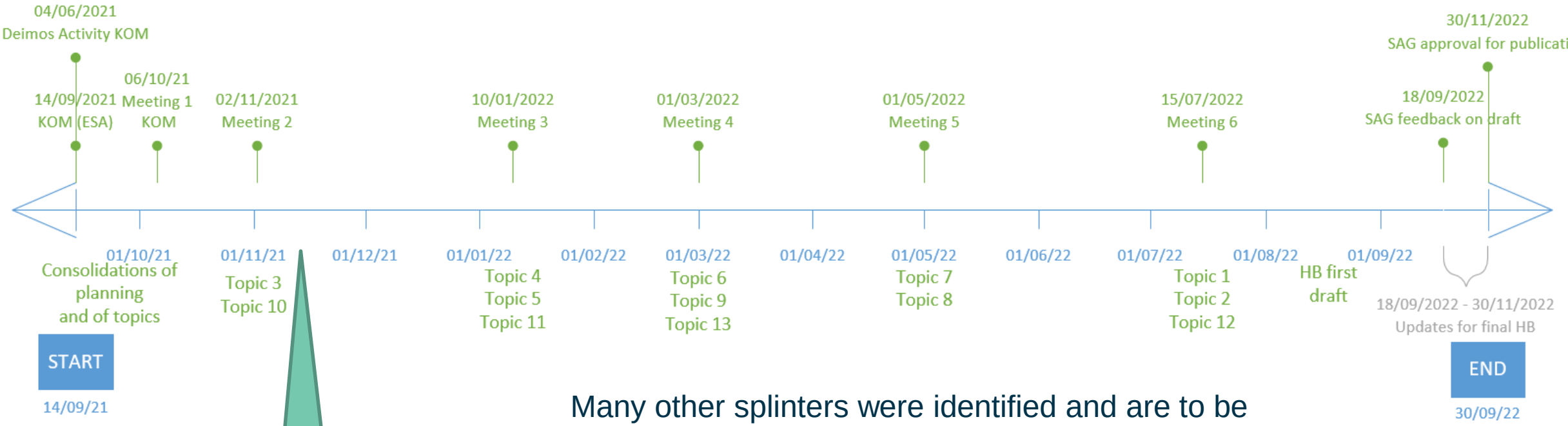
… and the most important => perform the update of the FDIR Handbook.

3. Major topics under discussion

1. Alignment with ESA mission classification
2. CubeSats/Small Sats performing complex missions
3. **Close Proximity Operations (e.g. in-orbit servicing, ADR, etc.)**
4. Use of RAMS analysis for FDIR definition
5. Use of MBSE in FDIR definition
6. Use of AI and ML for FDIR
7. Identify constellations gaps
8. Identify ground segment gaps
9. Establish timeline of FDIR concept definition
10. **Disposal**
11. FDIR tools recommendation
12. Verification approach for FDIR
13. NewSpace



4. Planning and timeline



Many other splinters were identified and are to be organised, such as:

- Splinter on RAMS
- Splinters on Close Proximity Operations
- Splinter on FDIR design within Power Systems
- Splinter on Verification and Validation of FDIR
- Etc…

5. Lessons Learned

Lessons learned from industry and ESA were provided:

- ✓ From missions
- ✓ From small studies
- ✓ From background activities
- ✓ From internal activities
- ✓ From review of handbook against other standards/handbooks/ technical notes

Current status of comments/suggestions/lessons learned:

Minor – 50 discussed in splinters or offline
Major – 13 discussed in meetings as per planning

Pending lessons learned from missions performing Close Proximity Operations, such as: PRISMA, PROBA-3, Gateway, MSR-ERO, etc.

6. Minor topics under discussion

Minor points raised – 50, among which several can be mentioned as being more interesting:

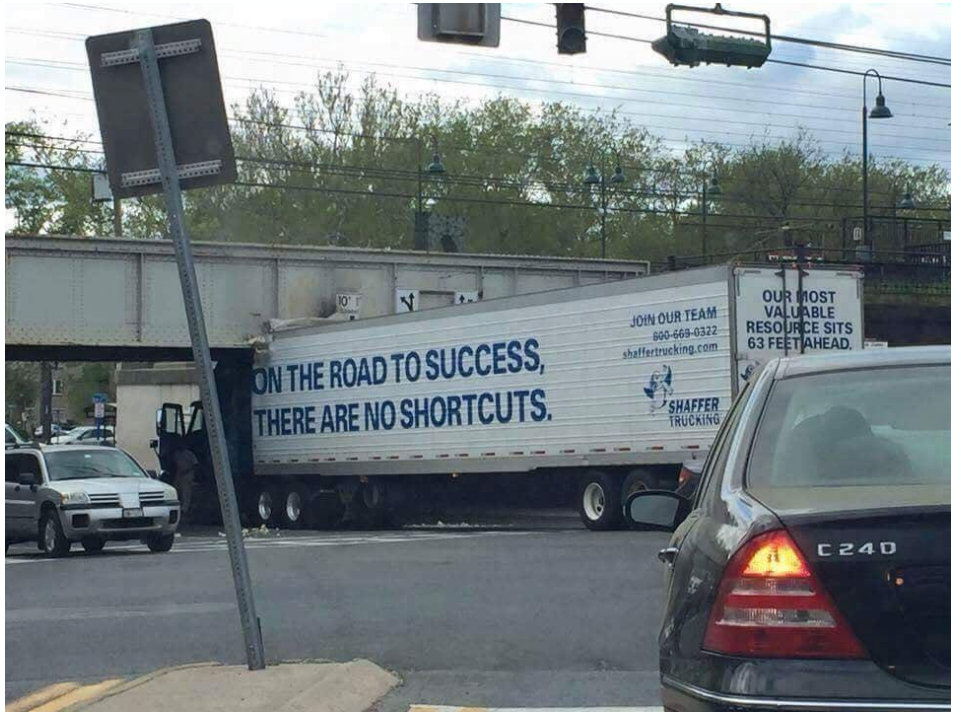
- Dependency analysis revision
- Minor RAMS aspects revision and alignment with ECSS
- Bringing updated version of the handbook in line with the generic OIRD evolution
- Alignment of handbook with decisions and updates ongoing within the PUS C WG
- Alignment of handbook with ongoing discussions within the SAVOIR Power WG
- Integration of basic assumptions within the update of the handbook

7. Background activities

Some of the new **research** activities (on top of those from phase 1) that can contribute to the updated of the FDIR HB:

- **Safe Rendezvous and Close Proximity Operations (ITT 9850)** - to provide the design principles and requirements allowing to perform CPO in a safe and reliable manner

- **Early in the loop MBSE assessment of electronics availability for Nano/Micro satellite missions** - to calculate (within MBSE) the availability of a satellite subsystem in order to perform trade-off analysis on different physical architecture capable to mitigate SEE event



7. Background activities

Some of the new **research** activities (on top of those from phase 1) that can contribute to the FDIR HB:

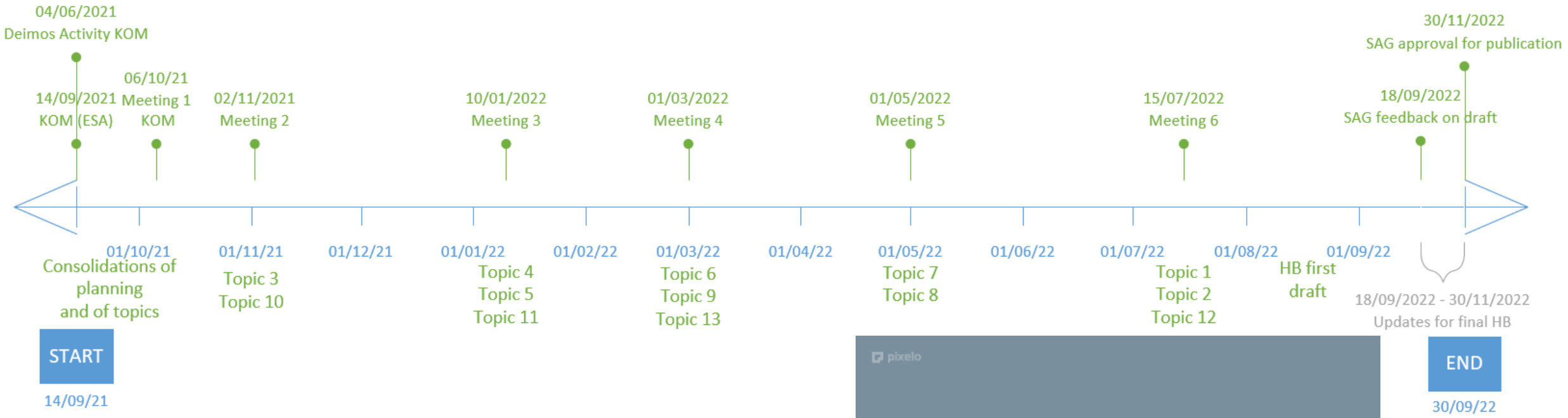
- **Model Based Avionics MB4SE** - to rethink the avionics using a different viewpoint such as functional chain instead of block
- **[COMPASTA] Compass to TASTE** – to integrate compass and test toolsets to bridge between architectural level design and system implementation (in MBSE)
- **Increasing RAMS for Small Satellites** - to design a FDIR for CubeSat/SmallSat missions in non-deterministic environment with limited resources, using the current body of knowledge and improve the FDIR state of the art
- **Machine learning-based on-board autonomy, failure prognostics and detection**

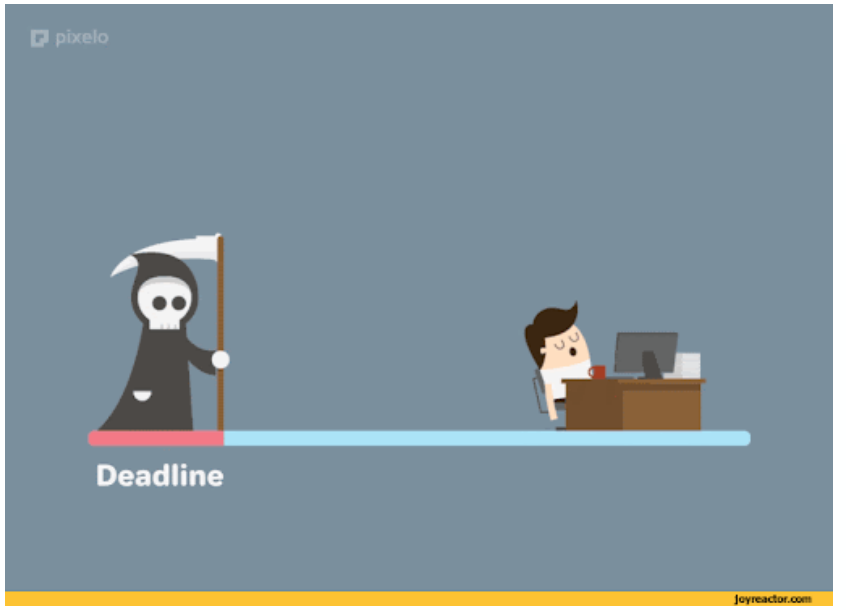
8. Meeting #2 outcomes

- Discussed different types of CPO/disposal missions with potential specific FDIR implications
- For CPO, need to be in line with the CPO guidelines (which does not cover specifically FDIR)
- Need to differentiate between cooperative and non-cooperative CPO
    - For non-cooperative (i.e. ADR missions): all FDIR on chaser spacecraft
    - For cooperative (IOS, formation flying): account for CPO both on chaser and target satellites -> need coordination in terms of FDIR (as FDIR on both satellites)

- Need to address more clearly the topic of dependency between FDIR monitors (linked to failure propagation) in the handbook

9. Way forward





- ✓ Remaining on track
- ✓ Next meeting topics: RAMS, MBSE and FDIR tools recommendations
- ✓ Several other splinters to be held before meeting #3
- ✓ 1/4 updates of the handbook to be performed ~ 02/22
- ✓ Next issue of the handbook 01/23

Thank you!