

# Avionics Embedded Systems - Technology Harmonisation Dossier & Roadmap

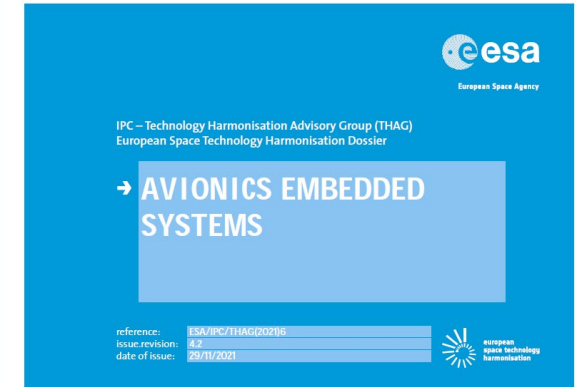
Kostas Marinis, H/TEC-EDD  
On-board Computers & Data Handling Section

ESA - ESTEC

ADCSS 2024, 22/10/2024

# Avionics Embedded Systems (AES) THD : Overview

- Avionics Embedded Systems (AES) control all on-board functions of a spacecraft, acting as its "brain" and accounting for about half of non-recurrent development costs.
- The need to improve (harmonise) the AES development process is critical to manage increasing complexity and to reduce costs.
- Harmonization should advance standardization and improve interfacing of functions to manage increasing complexity affordably.
- AES are critical, high-risk systems justifying increased harmonization effort and significant R&D focus.

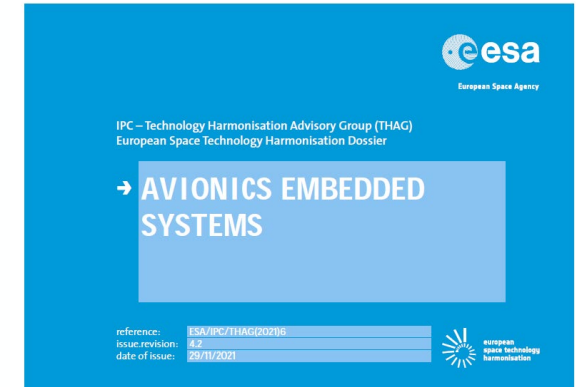


IMU Flight Model ExoMars 2020



Operations engineers can be seen working around part of the Galia Avionics Model

- Avionics Embedded Systems (AES) control all on-board functions of a spacecraft, acting as its "brain" and accounting for about half of non-recurrent development costs.
- The need to improve (harmonise) the AES development process is critical to manage increasing complexity and to reduce costs.
- Harmonization should advance standardization and improve interfacing of functions to manage increasing complexity affordably.
- AES are critical, high-risk systems justifying increased harmonization effort and significant R&D focus.
- Last Avionics Embedded Systems (AES) Technology Harmonisation Dossier (THD) was published in November 2021, due for update in 2025.
- Technology Harmonisation Dossiers and Roadmaps are publicly available:  
<https://technology.esa.int/page/harmonisation>



IMU Flight Model ExoMars 2020



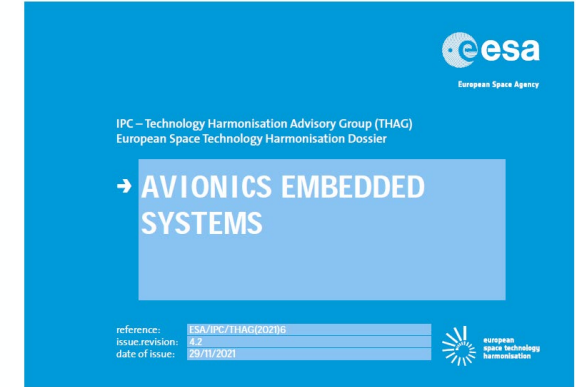
Operations engineers can be seen working around part of the Gaia Avionics Model

- **Avionics Embedded Systems THD - Scope:**

- The AES Technology Harmonisation Dossier (THD) covers system-level aspects of AES, including data, control, software, and TT&C (Telemetry, Tracking & Command) systems.
- Also includes hardware and software for command & control, failure detection, isolation and recovery (FDIR), and all mission and vehicle management functions.
- It addresses architectures and interfaces, avionics system functions, development processes, and related methods and tools.

- **Key Issues:**

- The need to enhance mission-critical capabilities such as autonomy, on-board data processing, and real-time sensing.
- Important to standardise avionics functions and interfaces to reduce time and resources dedicated in new developments
- Essential role of AES in all spacecraft and future missions requiring more intelligent functions on-board.



IMU Flight Model ExoMars 2020



Operations engineers can be seen working around part of the Galia Avionics Model



**Basic functions implemented by Avionics Embedded Systems:**

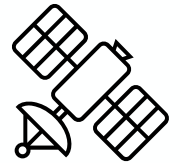
- Command & Control
- Fault Detection, Isolation and Recovery (FDIR)
- Attitude and Orbit Control / Guidance Navigation & Control (GNC)
- Thermal control processing
- Power control processing
- TM & TC handling
- Data processing, storage and transmission
- Data handling
- Payload control

**Relationship between Avionics Embedded Systems and other topics in the Avionics domain**

<b>Avionics Embedded Systems dossier:</b> roadmap listing Avionics level cross-sectorial activities and sectorial activities with a cross-sectorial scope			<b>On-board Radio Navigation Receivers dossier</b>
Data Systems sectorial activities with an Avionics level scope <u>defined</u> in AES dossier	Control Systems sectorial activities with an Avionics level scope defined in AES dossier	On-Board Software sectorial activities with an Avionics level scope defined in AES dossier	TT&C (E2E) sectorial activities with an Avionics level scope defined in AES dossier
<i>Data Systems</i>	<i>Control Systems</i>	<i>Software Systems</i>	<i>TT&amp;C E2E</i>
<b>On-board Computers, Data Handling Systems &amp; Microelectronics</b>	<b>AOCS Sensors and Actuators dossiers</b>	<b>On-board Software dossier</b>	<b>TT&amp;C transponders &amp; payload data transmitters</b>

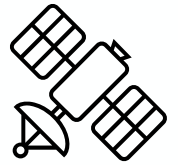
# AES Technology Development Roadmap

- The roadmap for developing avionic systems architectures and building blocks is designed to maximize the **reuse of specifications, designs, and products** from one mission to another, avoiding new developments that require time and resource-intensive qualification.
- This involves the **standardization of avionics functions and interfaces** and the development of **product lines** by industry to facilitate the reuse approach.



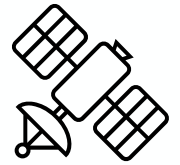
# AES Technology Development Roadmap

- The roadmap for developing avionic systems architectures and building blocks is designed to maximize the **reuse of specifications, designs, and products** from one mission to another, avoiding new developments that require time and resource-intensive qualification.
- This involves the **standardization of avionics functions and interfaces** and the development of **product lines** by industry to facilitate the reuse approach.
- Roadmap from AES THD 2021 contains a long **list of activities**, categorised by AIM and colour coded:
  - Green for “**Funded**”, Yellow for “**Partially Funded**”, Red for “**Not Yet Approved**”.
  - Audience can still refer to the roadmap for possible interest in activities not yet initiated.



# AES Technology Development Roadmap

- The roadmap for developing avionic systems architectures and building blocks is designed to maximize the **reuse of specifications, designs, and products** from one mission to another, avoiding new developments that require time and resource-intensive qualification.
- This involves the **standardization of avionics functions and interfaces** and the development of **product lines** by industry to facilitate the reuse approach.
- Roadmap from AES THD 2021 contains a long **list of activities**, categorised by AIM and colour coded:
  - Green for “**Funded**”, Yellow for “**Partially Funded**”, Red for “**Not Yet Approved**”.
  - Audience can still refer to the roadmap for possible interest in activities not yet initiated.
- The **new** AES THD 2025 **will not contain** any roadmap Excel tables.
- It will include only the dossier and a roadmap in a **written, high-level format**, describing the main technology goals and target objectives.





## GOAL 1: Avionic Systems Architectures

- **AIM A: Develop Avionic Systems Architectures and Building Blocks**  
Reference architectures, Interface Standardization, Communication networks and protocols, IMA, COTS-enabled systems, etc

## GOAL 2: Advanced Avionic Functions

- **AIM B: Pre-development and Maturation of Advanced Functions**  
Autonomous Functions, FDIR, Reconfigurable HW and systems, Operability, Security, Modular & scalable systems

## GOAL 3: Avionics Development Methods and Tools

- **AIM C: Improve the Avionics Development Processes Methods and Tools**  
MBSE (Avionics), EDS, HW/SW Codesign, Multicore, Avionics Test Means

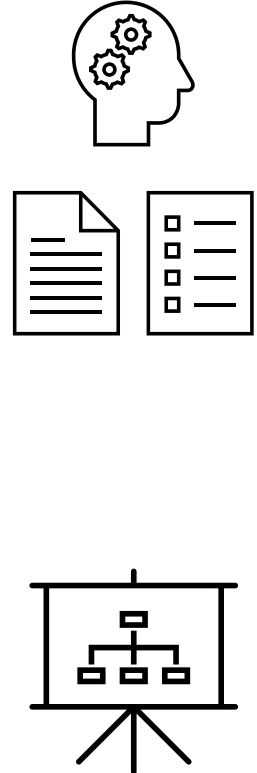
## GOAL 4: Technology Demonstrators / Pilot Applications

- **AIM D: Develop Technology Demonstrators / Pilot Applications**  
FDIR demonstrator, Multicore / IMA demonstrator, etc

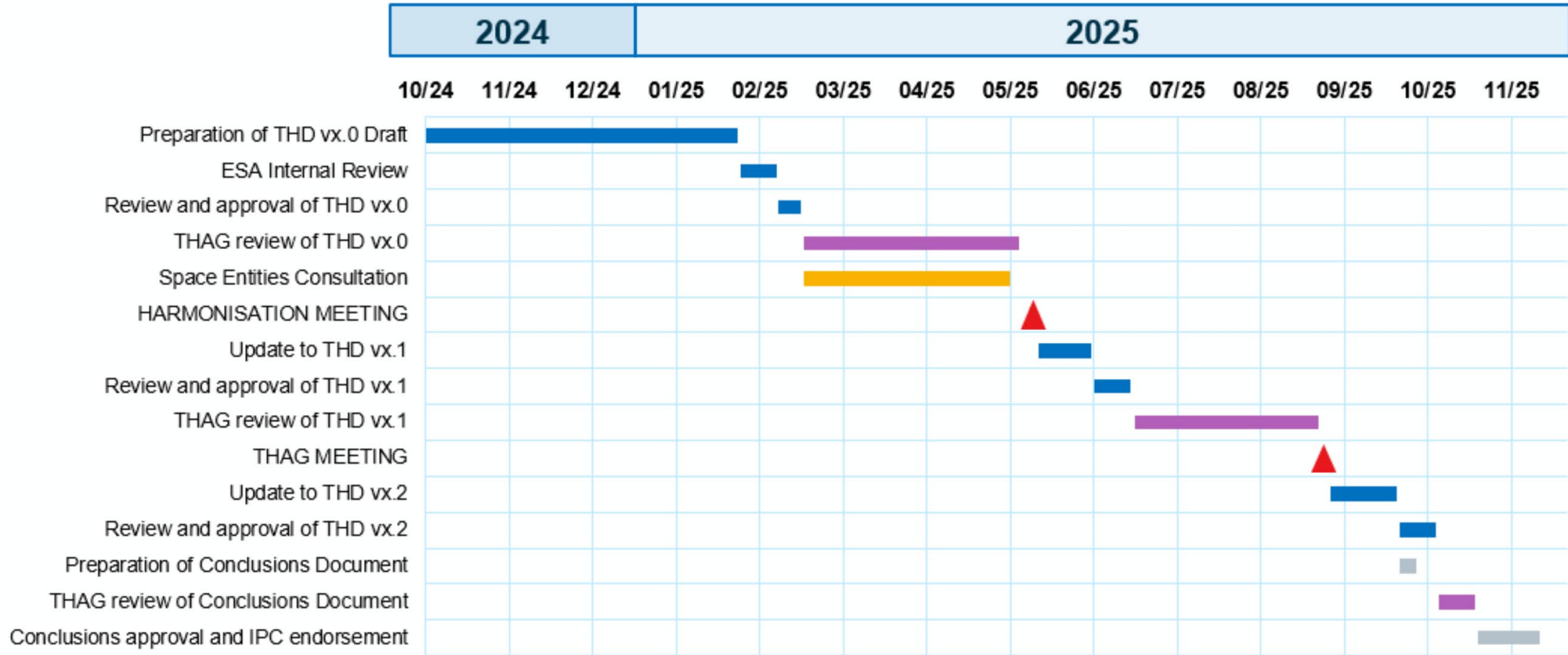
# AES THD 2025 : Preparation

- AES THD 2025 will be prepared by the **Avionics & EEE Division, Electrical Department** (previously done by the Systems Department)
- The recent organisational changes in the ESA TEC Directorate will be taken into account in the preparation of the new AES THD 2025 :
  - **Flight Software Section** now part of the (new) **Avionics & EEE Division**
  - New **Avionics & EEE Division** consists of the following sections:
    - Data Handling
    - Microelectronics
    - Components
    - **Flight Software**
    - **RHA & Component Analysis**
  - **AOCS** and **GNC Sections** are now in the **Electrical Department (TEC-E)** – (previously in the Systems Department)

New sections



# AES THD 2025 : Milestones



**Points of interest to external stakeholders:**

- Space Entities Consultation (yellow line)
- Harmonization meeting (1<sup>st</sup> red milestone) – open for everyone to attend
- Publication of documents, at the end of 2025, after IPC approval

Thank you for your attention

Questions?



Presenter:  
[Kostas.Marinis@esa.int](mailto:Kostas.Marinis@esa.int)