Advanced Data Handling Architecture (ADHA): Status, Current Activities and Roadmap

"Working towards a European solution for standardized Data Handling Systems"

ADHA Team (ESA and Industrial partners)

David Steenari, Kostas Marinis, Felix Siegle

On-Board Computers & Data Handling Systems | TEC EDD

ADCSS, 24 October 2024

Agenda

1. ADHA Background, Goals – Objectives, and Teams
2. ADHA System Studies (ADHA-2 and ADHA-3)
3. ADHA Industrial Involvement, Budgets, and Procurements
4. Upcoming/Future Activity Opportunities
5. Conclusions & Summary

1. ADHA: Background, Goals/Objectives and Teams

ADHA: Goals & Objectives

The aim of the Advanced Data Handling Architecture (ADHA) program is to:
Deliver a new generation of Platform and Payload Data Handling units, by 2027.

ADHA units are based on standardized, inter-operable and inter-changeable modules

- From multiple suppliers (multiple sourcing incl. SMEs).
- That can be integrated in ADHA units by different ADHA unit integrators.
- On all Large-Scale Integrator's (Primes) platforms.

ADHA targets both Class Alpha (I/II) and Class Beta (III) missions,
as well as commercial satellites.

- Standardised procurement flow for modules and units
- Standard PA/QA tailoring approach for procurements

ADHA 6U and 3U units, and 6U module.

ADHA uses standard form-factors (6U/3U) and backplane connector (cPCI-S-S).

ADHA: Benefits at System Level and Equipment Level

ADHA defines standard unit concepts that need to be developed only once, including:

- Mechanical/thermal concept, internal services of the unit / rack (power distribution, communication…), AIT concept

Benefits of integration of multiple functions in single units (e.g. OBC/MM/RTU, or ICU/DPU):

- Reduction in overall SWaP (Size, Weight and Power):
  - → Fewer overall electronics boxes
  - → Single bus voltage power converter per unit
  - → Less external harness volume and mass
- Scalability and modularity provide flexibility in unit configuration and expansion
- Uniformity across DHS unit dimensions – facilitates area and placement optimisation within the spacecraft structure.

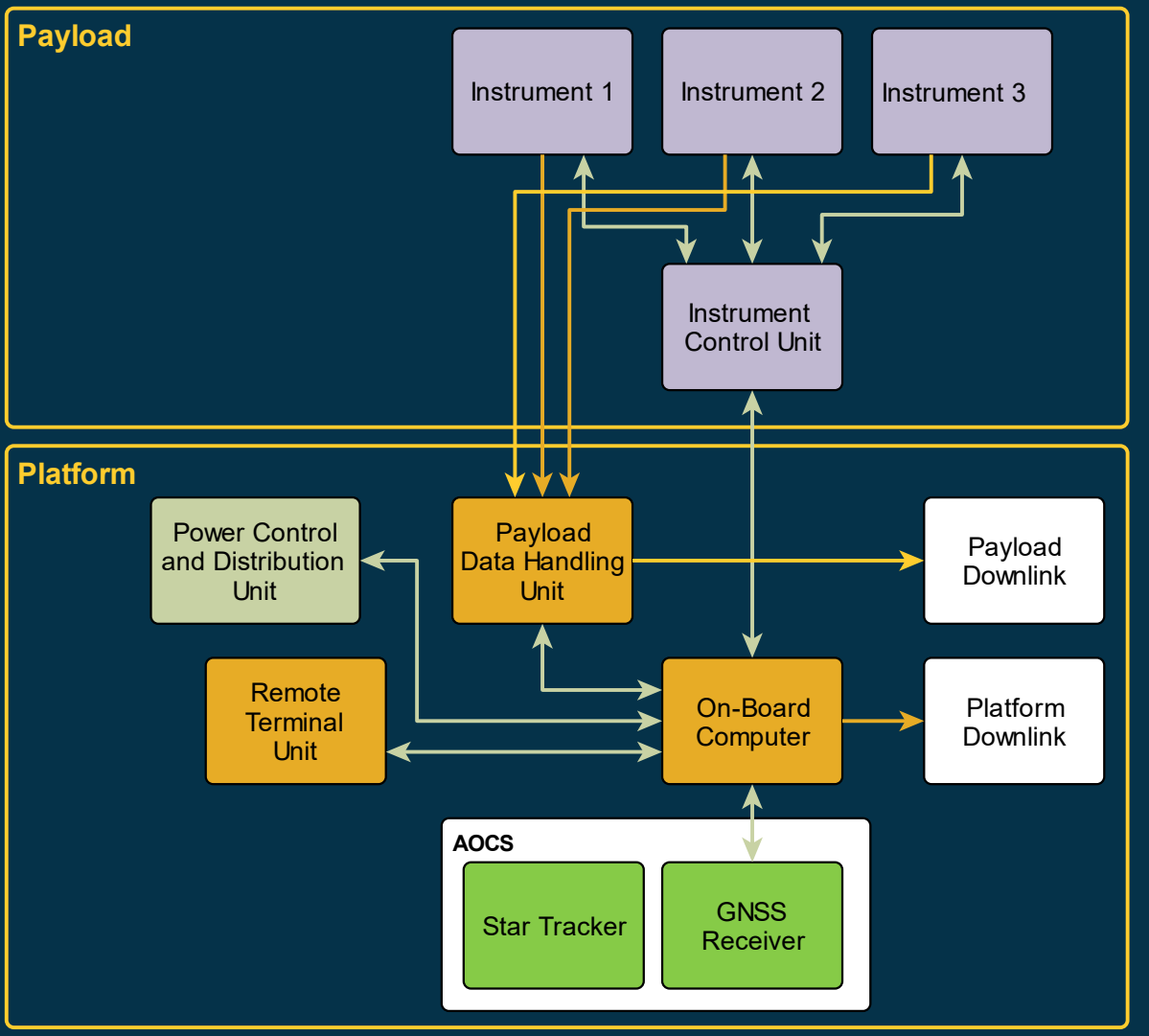
Procurement benefits:

- Flexibility in implementation of georeturn requirements for institutional missions
- With time, increasing portfolio of available boards (modules) – allowing further flexibility in function/performance/supplier optimization – and faster AIT and early testing for mission critical functions

Benefits of ADHA & APA

- ADHA and APA (Advanced Power Architecture) modules can be deployed throughout the whole avionics architecture of a spacecraft, Platform & Payload

- High reusability reduces costs and development time and can significantly speed up the procurement and review process.



Simplified avionics architecture of ESA EO Mission

Benefits of ADHA & APA

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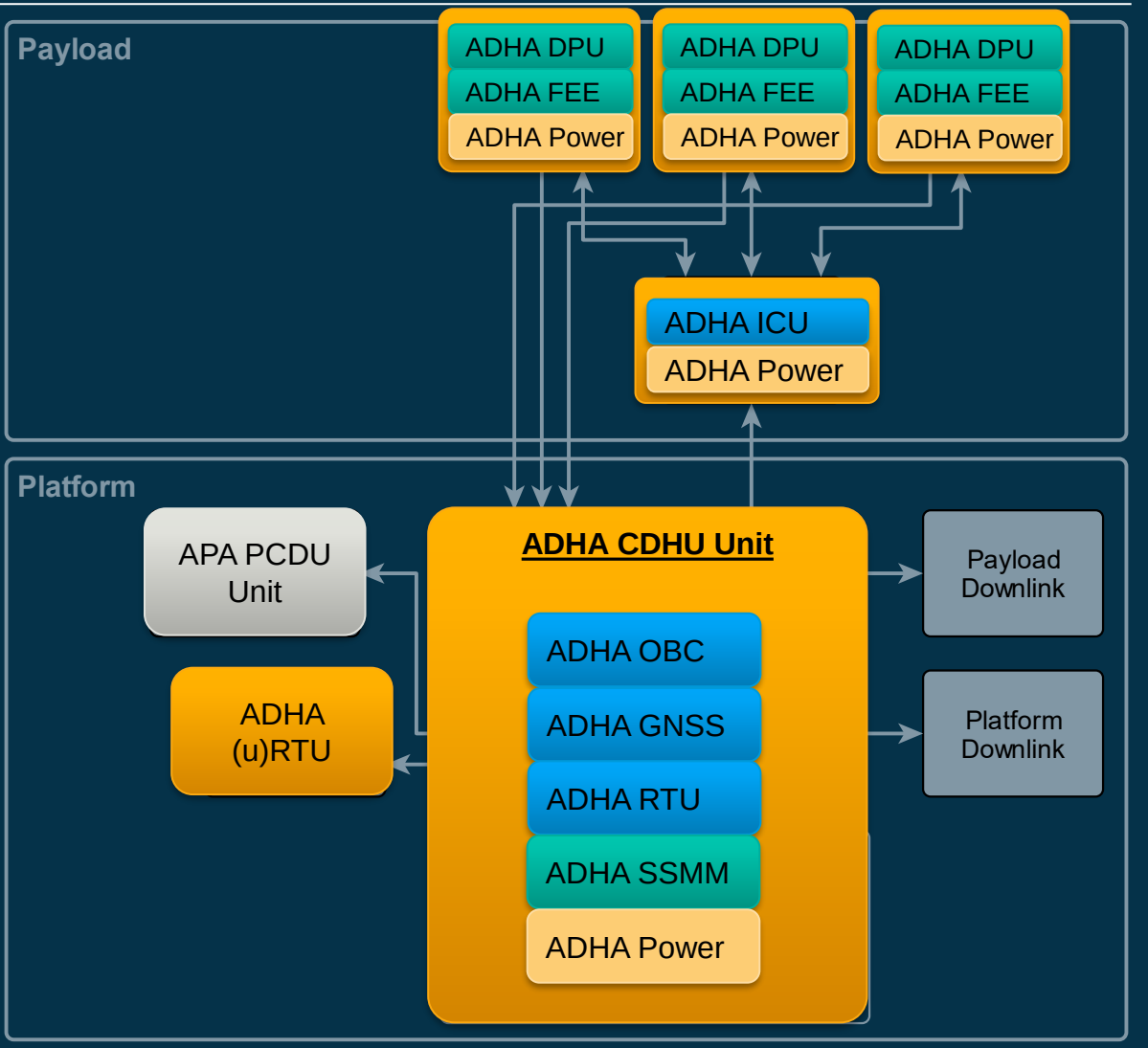


Simplified avionics architecture of ESA EO Mission – adopting ADHA

ADHA: Development Status, System Studies and Units/Modules

The ADHA program consists of the ADHA System Studies (“ADHA-1”,” -2” and “-3”) - and ADHA Module and Unit Development activities.

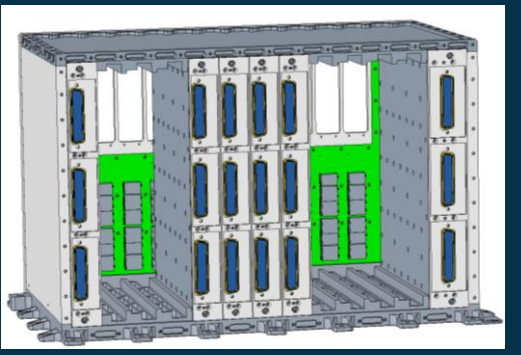
The ADHA System Study is currently in the second phase (“ADHA-2”):

- two parallel contracts, primed by ADS (DE) and TAS (IT)
- with contributions from OHB (DE), Beyond Gravity and DSI.

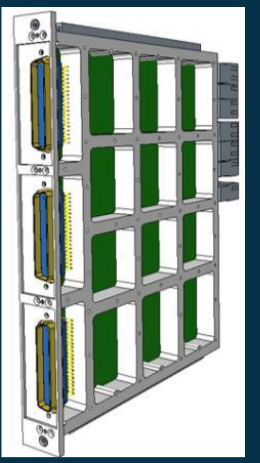
In parallel, >20 ADHA related activities have been funded under ESA programmes (both ESA and industry driven), including:

- the development of >20 different ADHA 6U and 3U modules,
- and development/testing of key elements (e.g. backplane connector).

Involvement from many major DHS equipment suppliers and SMEs:
ADS (FR), Beyond Gravity (SE, FI), ADS CRISA (ES), TAS (IT), DSI (DE), GMV (RO), KP Labs (PL), EvoLeo (DE, PT), Frontgrade Gaisler (SE), AST (PT), etc.



ADHA 6U unit design



ADHA generic 6U module

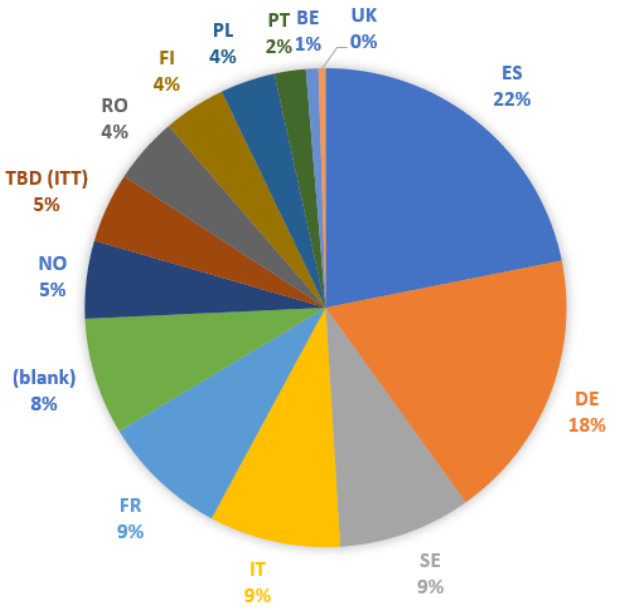
ADHA: Current Contracts, Industry and Budgets

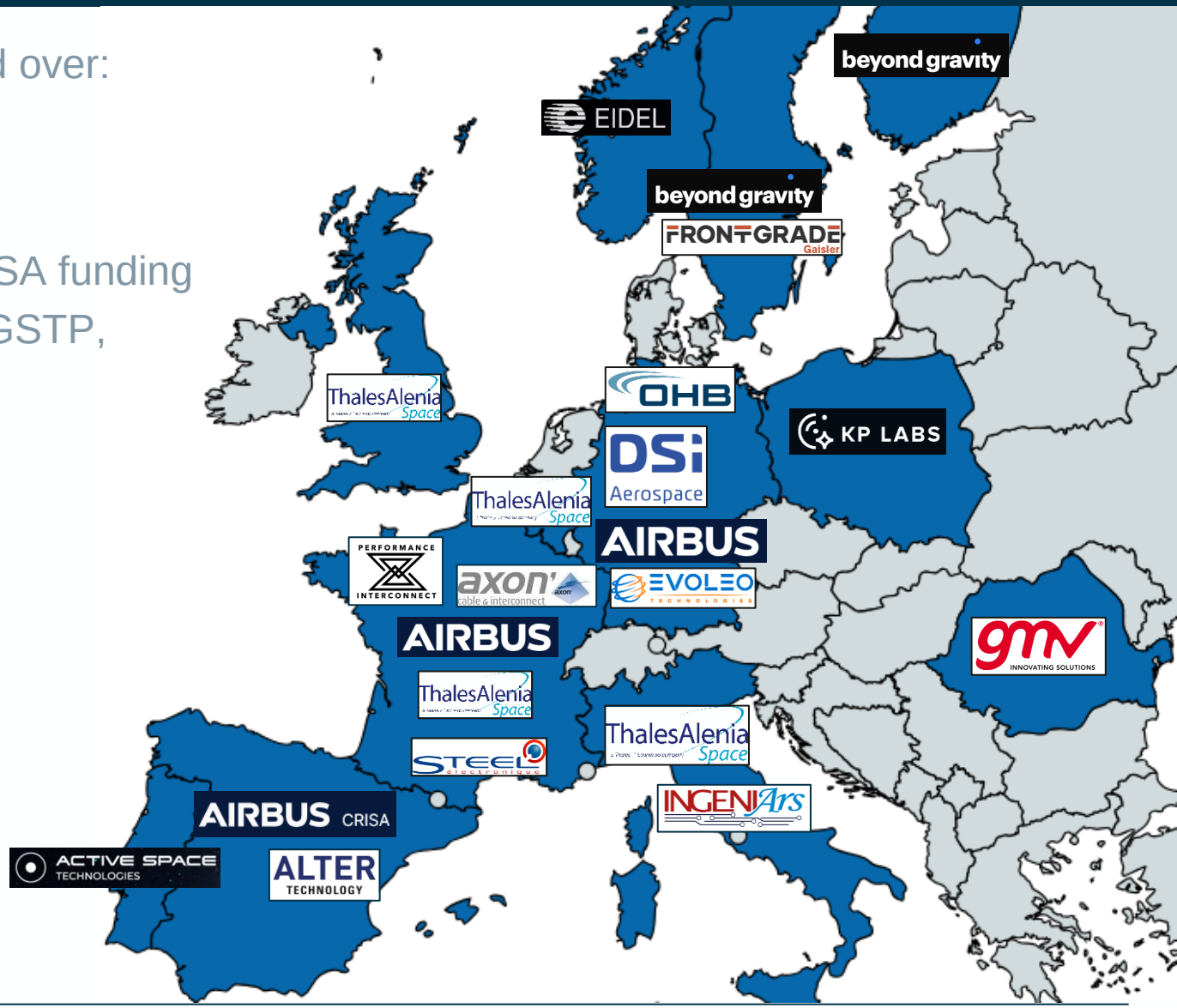
The overall ADHA development activities are divided over:

…**16 companies and groups**

…in **12 European countries**

…for a **total budget of ca 22MEUR** from multiple ESA funding programs (FutureEO, Discovery/Preparation, TDE, GSTP, InCubed, ARTES)





ADHA Teams of the ADHA-2 Study : ESA

ESA ADHA Core Team (in TEC-EDD)

Kostas Marinis, H/TEC-EDD

ADHA Coordinator
ADHA OBCs

David Steenari TEC-EDD

ADHA Coordinator
ADHA Payload Modules

Felix Siegle TEC-EDD

ADHA Lab Facility Manager,
ADHA SSMM Modules

ESA ADHA TOs & Support Team

Alberto Valverde, TEC-EDD
ADHA Remote Interface Units

Malte Bargholz, TEC-EDD
ADHA Payload Modules

Antonis Tavoularis, TEC-EDD
ADHA OBC Modules

Hadrien Carbonnier, TEC-EPM
ADHA Power Design

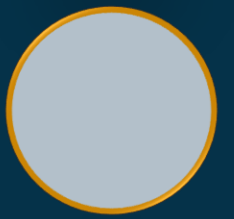
Enrico Melone, TEC-EDD
ADHA Module Dev. Support

Bruce Yu, TEC-EDD
ADHA Module Dev. Support

Maris Tali, TEC-EDD
ADHA Module Dev. Support

Eleonora Mariotti, TEC-EDD
ADHA MBSE

Leo Farhat, TEC-EDC
ADHA Connectors



Benoit Laine, TEC-M
ADHA Mechanical/Thermal

Federico Anzani TEC-EDS
ADHA SW Design

Ivan Lapin, TEC-ESN
ADHA GNSS Module

ADHA Teams: ADHA-2 System Study Industrial Teams

Consortium 1

ADS-DE (as lead team)
&
RUAG-SE, RUAG FI, RUAG AT, ADS-FR, DSI (as members).

Consortium 2

TAS-I (as lead team)
&
TAS-FR, TAS-BE, TAS-UK and OHB-DE (as members)

ADHA Industrial Prime Team Leaders

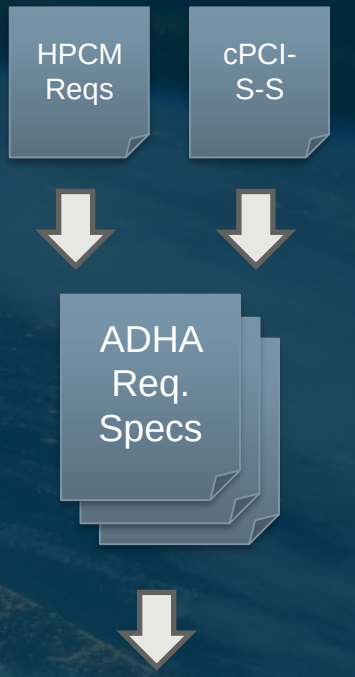
Julian Bozler
AIRBUS DS

Dario Pascucci
Thales Alenia Space

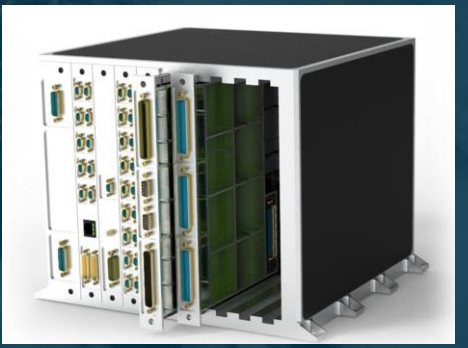
2. ADHA: Status of System Studies

ADHA – System Study Background and Status

- **ADHA-1 System Study completed in 2020**
  - Concluded on the ADHA architecture, and usage of cPCI-Serial-Space Standard as a starting point, with two form-factors: 6U and 3U.
  - DHS architecture defined.



- **ADHA-2 System Study** ("ADHA Consolidation, Standardisation, and Product Suite Development)" **running since 2021** (budget 2MEUR, FutureEO/Discovery)
  - Used HPCM (High Priority Copernicus Missions) as basis for system requirements.
  - ADHA requirements document on System, Unit, and Module levels published 2023.
  - ADHA-1 Phase-1 completed in October 2024.
  - Will conclude in Phase 2 with the AIT campaign of the Core 6U-ADHA EM Units, utilizing ADHA EM modules of Power, OBC and Solid-State Mass-Memory.



- **ADHA-3: An expansion of the System Study has been approved at IPC, October 2024.**
  - Additional budget of 2.5MEUR, funded through FutureEO and Discovery.

ADHA System Studies Developments

cPCI-S-S

ADHA Req. Specs

ADHA-1

- Agreement with industry to use cPCI-S-S Standard
- Architectural definition

ADHA-2

- ADHA Requirements Specs Issue#1 Published (2023) – mainly 6U
- 3x Core 6U-ADHA platform modules
- 2x 6U-ADHA Unit developments
- 6U-ADHA platform modules to be integrated in ADHA Units

ADHA-3

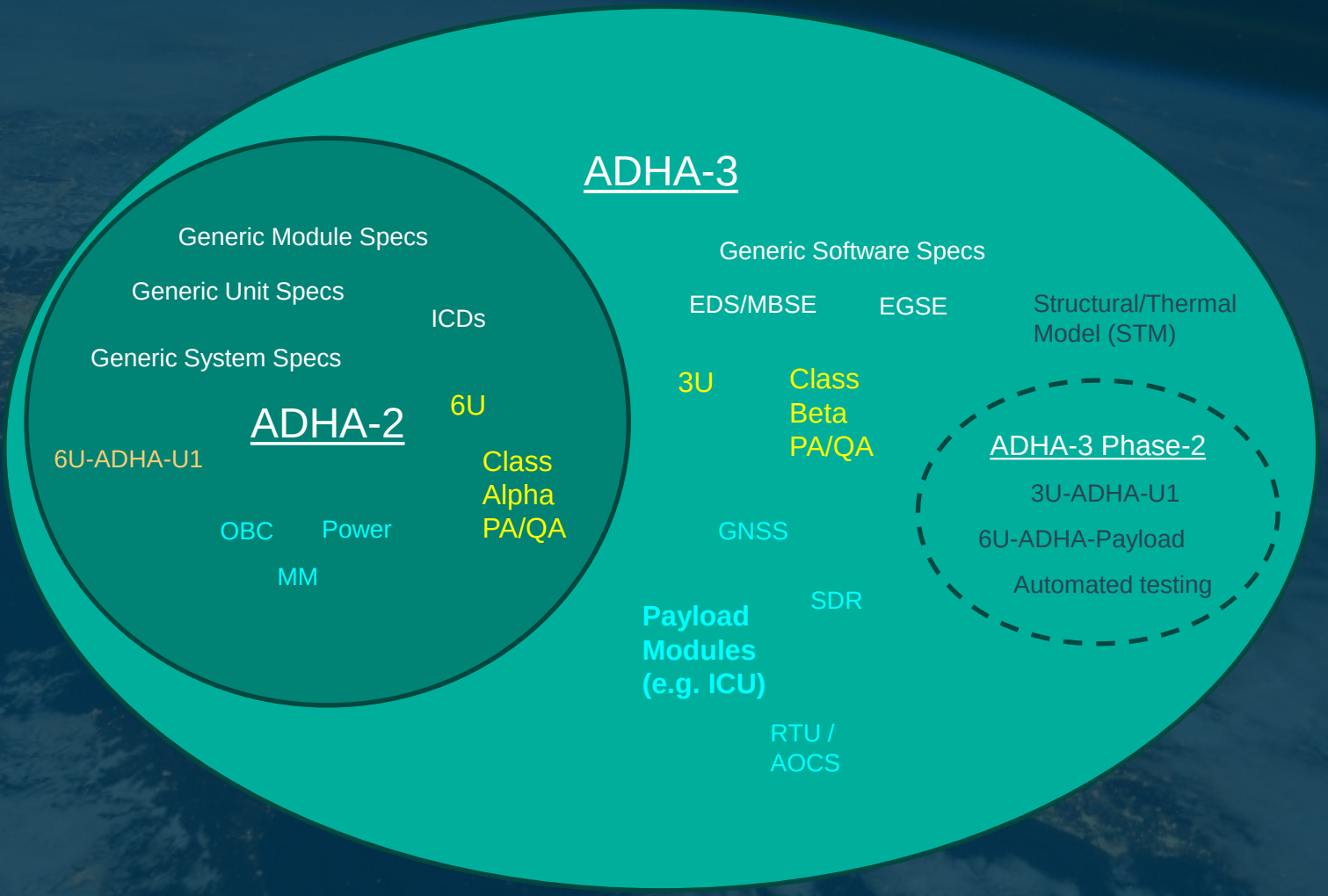
- ADHA Payload requirements specifications to be defined
- ADHA 3U requirements specifications to be defined
- Extended AIT campaign:
- 6U-ADHA Payload Units
- 3U-ADHA Platform/Payload Units

2019-2020 | 2021-2026 | 2025-2027

ADHA-2 to ADHA-3 Expansion of Topics

The ADHA-3 study will expand the scope of the ADHA Specifications to the following areas:

1. ADHA-3U Specifications
2. Class Beta PA/QA tailoring
3. ADHA Software and Protocol Specifications and prototyping
4. ADHA Payload Module (and ICU) Specifications
5. Additional ADHA Module Specifications (RTU, GNSS, SDR)
6. ADHA EDS Format Specification
7. ADHA Structural/Thermal Prototyping
8. ADHA EGSE



ADHA: Status of Public ADHA Specifications Datapack

Current release of ADHA Specification Datapack

- ADHA system unit and module specifications have been defined,
- ADHA Specifications DP V1R0 available on the ADHA website.

Future releases:

- V1R1 – Targeted release end of 2024
  - Updates to ADHA specifications: ADHA Generic Module Specification, MDIR, MICD, ADHA environmental specifications (alignment with APA), CAN spec, etc.
  - Update to MICD, but will not contain updated Mechanical and Thermal Simulations

- V1R2 – Targeted release early 2025
  - Update to V1R1, mainly targeting the updated Mechanical and Thermal Simulations

- V1R3 – Targeted release timed with EDHPC2025 conference (TBA) -- to contain 1st outcomes from the ADHA-3 study

Feedback on ADHA Specifications very appreciated – already received from several industrial partners – Thank you!

3. ADHA: Module/Unit Procurements Status

ADHA: Eco-Systems and Mission Targets

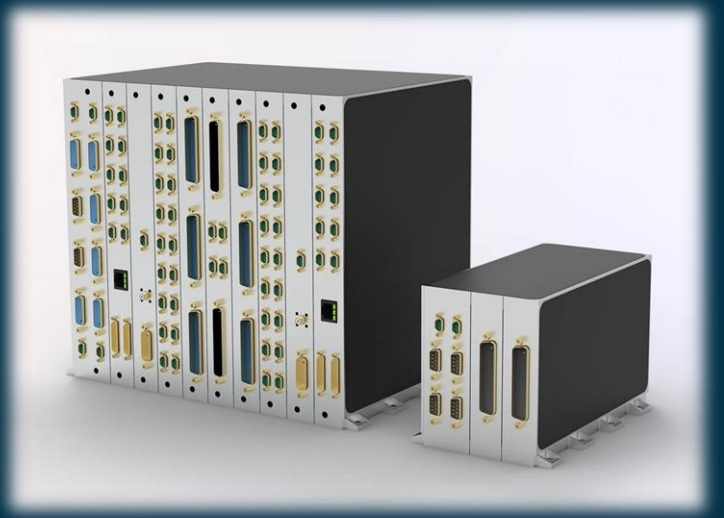
Currently envisioned to have two compliant ADHA eco-systems:

1. ESA Mission Class 1/2 (“Alpha”), i.e. mainline ESA (EO) missions
   – utilising mainly 6U modules, with “classical” RHBD components

2. Mission Class 3 (“Beta”), i.e. Small-Sat and Constellations
   – utilising mainly 3U modules, with RHBD / RT / up-screened COTS, in plastic packages

ADHA workplan and roadmap includes full eco-systems with dual-sourcing of key ADHA modules (OBC, mass-memory, power, RTU, ICU, DPU, etc.)

See presentations from ADHA sessions in EDHPC2023 conference for a full overview.



Status of ADHA EM/EQM Modules Procurements

Goal: To have **double-sourcing** for each of the key modules – for each of the mission class targets**.**

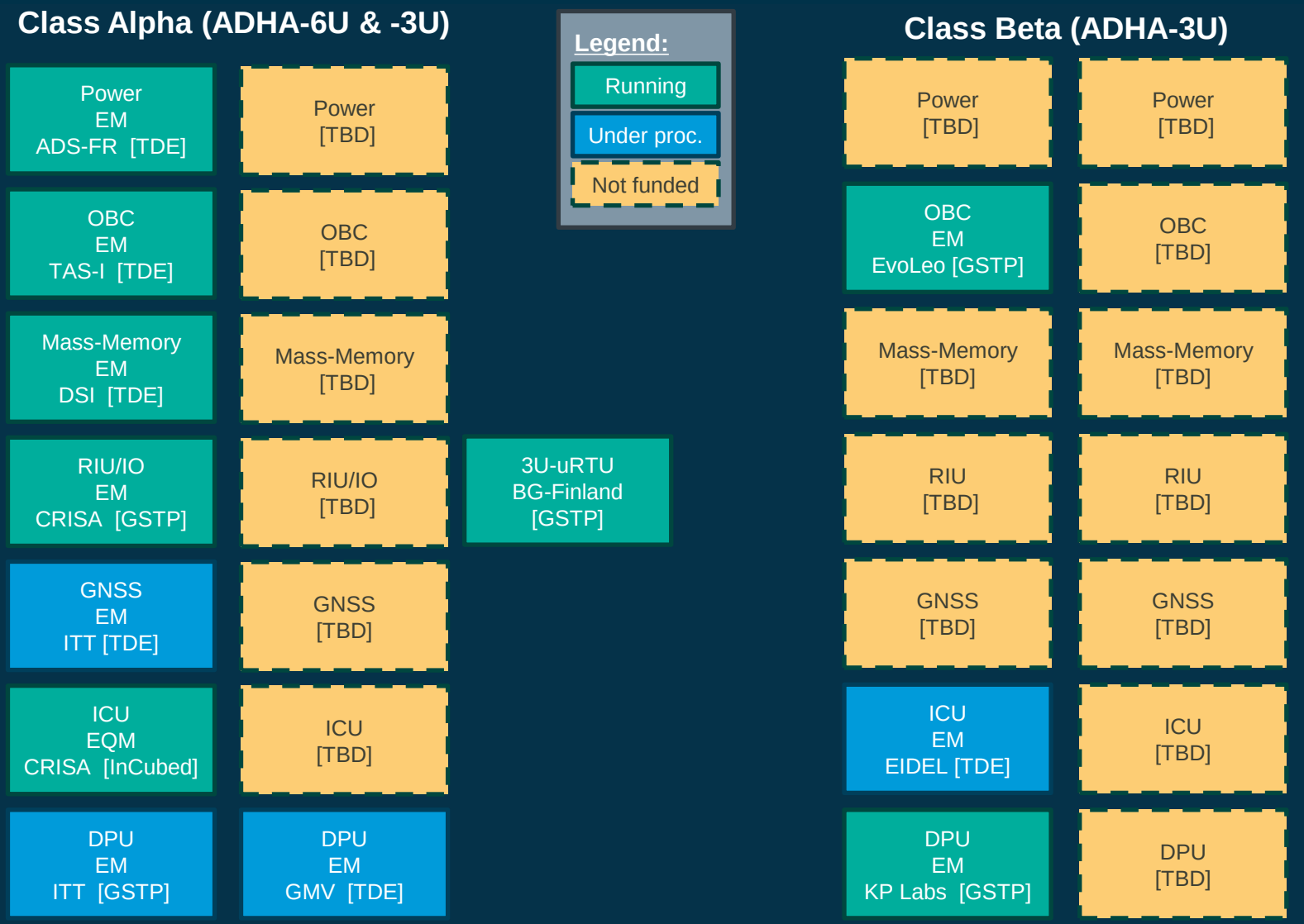
Two mission criticality class targets:

1. **Class Alpha**
   - mainly **ADHA-6U**
   - *some ADHA-3U (uRTU, uFEE, etc)*
2. **Class Beta**
   - mainly **ADHA-3U**

Separate – but compatible – eco-systems for the two targets.

Other modules under consideration:

- SDR, Security, Payload FEE, etc.

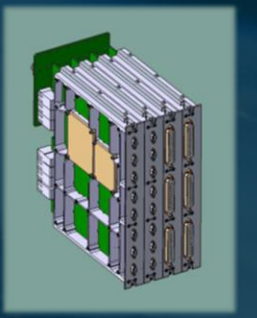


ADHA Module Developments:
Core 6U-ADHA Modules (Class Alpha)

The 6U-ADHA Core Modules developments for Class Alpha consists of three developments: OBC, MM and Power Module.

Generic OBC, MM and Power Module specifications have been developed as part of the ADHA-2 studies.

All three modules are developed under TDE, and were allocated as open competition (ITTs).



ADHA OBC Module (AOBCM) EM: [See also TAS presentation in this session]

- Objective: To develop the 1st ADHA 6U OBC, in fully redundant configuration
- Contractor: TAS (IT), Budget 1250 KEur. Kicked-off in 2024Q1

ADHA Mass-Memory Module (A3M) EM: [See also DSI presentation in this session]

- Objective: To develop the 1st ADHA 6U Mass-Memory Controller/Router and Extension Modules
- Contractor: DSI (DE), Budget 950 KEur, Kicked off in 2024Q2

ADHA Power Module (APwRM) EM: [See also ADS presentation in this session]

- Objective: To develop the 1st ADHA 6U Power Module
- Contractor: ADS (FR), Budget 350 KEur, Kicked off in 2024Q3

All three modules will be integrated as part of the ADHA-2 System Study AIT campaigns in the "ADHA-U1" units.

-- both at ADS-DE and TAS-I premises (see next presentations).

ADHA Module Developments: RTUs/RIUs (Class Alpha)

Two RTU/RIU developments are on-going under ESA funding:

Beyond Gravity-Finland **uRTU ("Next Generation IO System") EM**

- ADHA-3U form-factor
- Full Micro-Remote Terminal Unit (uRTU) – free-standing from OBC
- With generic I/O capabilities, and AOCS and Propulsion Control

ADS CRISA – **STREAM ("Standardized RIU Electronics in ADHA Modules") EM**

- 6U form-factor, Generic RIU I/O modules, AOCS and Propulsion Modules
- Can be integrated in OBC or free-standing (with additional controller)
- Presented at EDHPC2023 -- **[See also ADS presentation in this session]**

Study on standardisation of RTU/RIU functions and I/O planned as part of the ADHA-3 system study tasks.

- May result in Generic ADHA I/O Module Specifications for different functions.

ADHA Module Developments: Payload Modules (Class Alpha)

Several payload modules on-going on ADHA-6U form-factor for Class Alpha missions:

Instrument Controller Unit (ICU) EQM: ADS CRISA – NICE ("New Instrument Controller Electronics")

- 6U ICU Processor Module, placed in ADHA System Controller Slot, and Advanced Power
- Allows free-standing ADHA Payload Units, integrating different payload modules.
- Presented at EDHPC2023 - **[See also ADS presentation in this session]**

Co-Processing Module (CPM) EM: TBA (under negotiation) – ("HIPER-PRO")

- Development of high-performance payload processing module for future EO missions
- KOM in 2024Q4, funded through GSTP Element 1.

Co-Processing Module (CPM) EM: GMV-Romania ("ADHA-IPU-AI: Image Processing Unit and AI")

- Development of high-performance payload processing module for payloads and visual navigation
- KOM in 2024Q4, funded through TDE IPTF Romania – early concept presented at EDHPC2023

Also: **Co-Processor Module (CPM):** Frontgrade-Gaisler ("HPCB-ADHA") – breadboard activity.

ADHA 3U-Module Developments for Class Beta

Several on-going activities for Class Beta Equipment on ADHA-3U form-factor for small-sats:

3U-ADHA OBC Development EM – EVOLEO (“CHICS”)

- Development of OBC Processor Module and Reconfiguration Module for small-sats
- Allows to build-up ADHA-3U Platform Units.
- Presented at EDHPC2023

3U-ADHA Instrument ICU / SBC Development EM – EIDEL (“NX-ERIU”):

- Development of 3U-ADHA Single-Board Computer that can be used in RTU/ICU/etc
- Allows free-standing 3U-ADHA Payload Units
- **[See also presentation in this session at ADCSS2024]**

3U-ADHA Payload (Co-) Processing Module EM: KP Labs (“Lion DPU”):

- Development of high-performance processing module for future imaging payloads
- Can be integrated into 3U-ADHA payload (or platform, e.g. MM) units

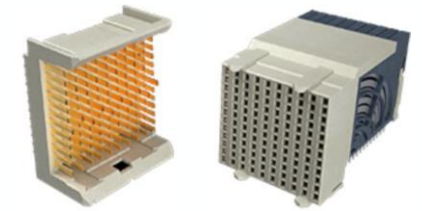
ADHA Backcplane Connector Developments

On-going activities for increasing the TRL of ADHA (cPCI-S-S) backplane connectors:

TDE Small-Activity: **“Procurement and reliability assessment of high data rate press-fit cPCI SS connector”** with ALTER

The aim of this activity is double:

1. to procure and assess the reliability of existing high data rate press-fit connectors compatible with cPCI SS: The commercial AirMax® manufactured by Amphenol, USA/China.
2. to support the development and assess the reliability of the HyperBits™ S-FECT (Performance Interconnect, FR).



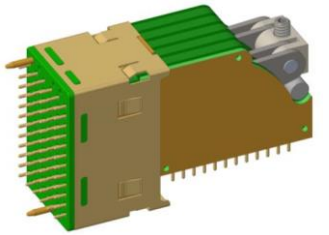
TDE **“Board Interconnections for High Data Rate applications”**, With AXON

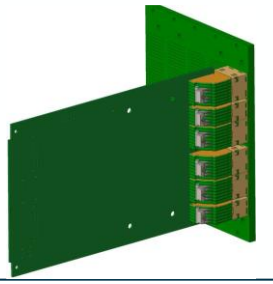
- The objective of this activity is to develop interconnection solutions based on innovative solderless technologies to withstand future requirements in terms of High Data Rate (HDR, up to 56Gbps).

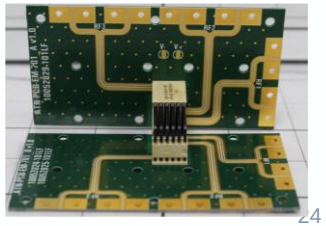
ARTES AT **“Development of High Density Modular Electrical Interconnections for High Data Rate Applications”**, with ALTER

The objective of this activity is to design, develop and test a suite of engineering models of modular backplane high density connectors for high data rate space applications, compatible with the cPCI serial space standard:

- enabling routing of more than 120 channels
- achieve an interface bit rate of at least 25 Gbit/s with a goal of 56Gb/s for long-term missions.







Detailed presentation on ADHA/cPCI-S-S backplane connectors provided at EDHPC2023.

4. ADHA: Upcoming/Future Activity Opportunities

ADHA Class Alpha Equipment Roadmap: Raising TRL & Dual-Sourcing

Plan to bring ADHA-U1 unit to EQM, to enable usage on future ESA Missions:

- General intention from ESA to increase the TRL of the Core ADHA modules for Class Alpha missions (6U-ADHA OBC, Mass-Memory and Power Modules) to the level of EQM -- funding TBD (e.g. GSTP, or other optional R&D programme)

Dual-sourcing of Core 6U-ADHA Modules for Class Alpha:

- General intention from ESA to ensure dual-sourcing of key ADHA elements
- Opportunities to develop second-source for Core ADHA modules for Class Alpha:
  - 2nd 6U-ADHA OBC to the level of EQM
  - 2nd 6U-ADHA Mass-Memory to the level of EQM (draft activity outline available for discussion)
  - 2nd 6U-ADHA Power Module
- Dual sourcing funding TBD (e.g. through open ITT under GSTPe1, or DN with suppliers under optional programme)

Additional opportunities for Class Alpha equipment to be funded through ESA optional programmes:

- E.g. develop 6U-ADHA Class Alpha Modules for Payload (e.g. ICU Controller Module, ICU I/O, Payload power, etc) and Platform functions (RTU and AOCS I/O, SDR/Software Defined Radio transponder/receiver, Security, etc)
  - Interested companies may get in contact with the ADHA ESA Coordinators to discuss.

ADHA Class Beta Equipment Roadmap: Opportunities for Equipment Suppliers

Some 3U-ADHA Class Beta developments already on-going (see previous slides).

Note that 3U-ADHA specifications and ADHA Class Beta PA/QA tailoring will be provided as part of the ADHA system study ("ADHA-3" CCN) during 2025.

Opportunities for 3U-ADHA Class Beta Modules/Units:

- Opportunity to develop 3U-ADHA Class Beta Modules/Units for Platform (OBC, MM, RTU, GNSS)
- Opportunities for 3U-ADHA Class Beta Modules/Units for Payload (ICU PM, ICU I/O, Front-Ends, etc)
- Opportunity to develop 3U-ADHA Class Beta general purpose power modules (for platform and payload)
- Other modules also under consideration: SDR (Software Defined Radio) / transponder, Security, etc.

Interested companies may get in contact with the ADHA ESA Coordinators to discuss.

ADHA Upcoming Activities: Planned Open ITTs

Two upcoming ADHA-related open (competitive) ITTs (Invitation to Tender):

TDE activity T701-806ED : “Model-Based Systems Engineering (MBSE) applied to Advanced Data Handling Architecture (ADHA) products”:

- Objective: “To develop a methodology, toolchain and modelling guidelines for introducing in a coherent way the MBSE techniques in ADHA units development cycle”.
- Budget: 300kEUR, duration: 12 months
- Target ITT date: late 2024 / early 2025 (TBC)

TDE activity T101-803ES “ADHA GNSS Receiver Module (AGNSSRxM)”:

- Objective “To develop a GNSS Receiver module compliant with the SAVOIR reference architecture and the ADHA specifications.”
- Budget: 500 kEUR, duration 18 months
- Target ITT date: late 2024 / early 2025 (TBC)

5. ADHA: Summary/Conclusion

ADHA Status: Summary and Conclusion

The Advanced Data Handling Architecture (ADHA) program is fully on track, having full momentum, and even more increasing interest from industry.

- ADHA Specifications have been published in 2023, updated versions with feedback from industry to be released late 2024.
- On-going ADHA System Study (“ADHA-2”) will conclude with an AIT campaign of an ADHA 6U unit (with OBC, MM, Power modules)
- Funding secured for continuation of ADHA System Study (“ADHA-3”)
  - To further develop and expand the ADHA Specifications (Payload, Software, 3U-ADHA, Class Beta)
  - Prototyping of Mechanical/Thermal, and Software elements
- Several new module and unit developments funded, to the level of EM.

- Future plans to develop a full eco-system with dual-sourcing, and to fund module/units to EQM – to ensure future adoption of ADHA units in ESA missions.

Thank you for your attention

Questions?

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BACKUP SLIDES