

# CoRA - Compact Reconfigurable Avionics - MBAD

C. Honvault, J. Iltstad, D. Oddenino

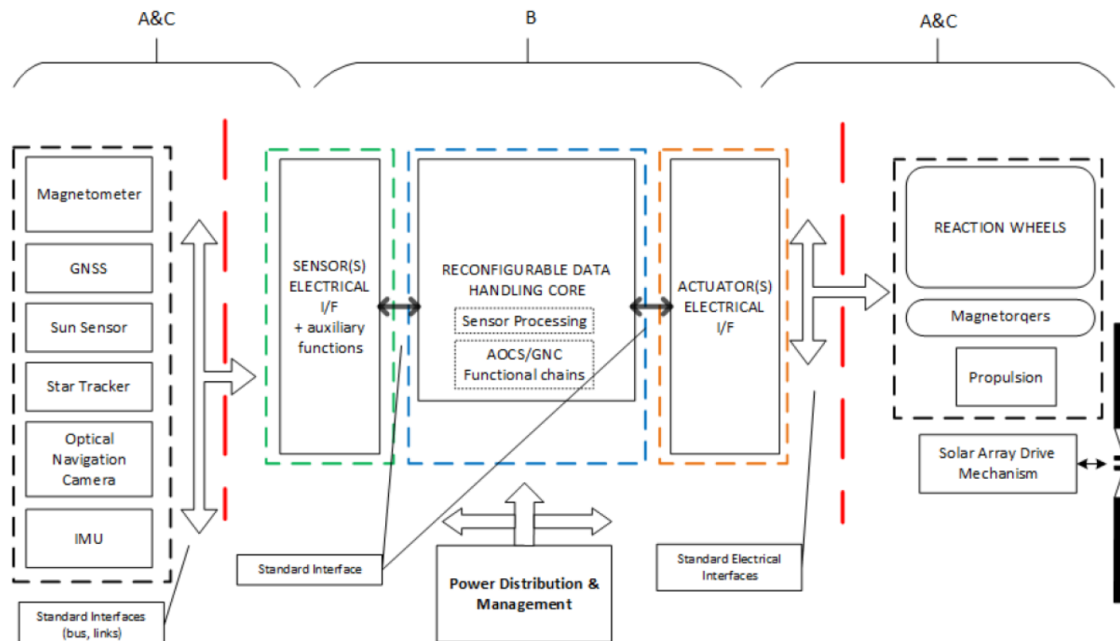
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The Compact Reconfigurable Avionics shall demonstrate the flexibility, reliability and usefulness of a highly configurable system(s) developed by using Model Based Avionics engineering. It could be applicable to any mission, but the concept shall be demonstrated here for a strawman mission, typically for small spacecrafts to reduce the size of their avionics (data handling core and smart AOCS&GNC elements) while being reliable, either using rad hard technology or by applying system level hardening.

CoRA is one overall avionics activity organised as a set of three activities covering three domains of avionics:

- Hardware: Reconfigurable Data Handling core
- Software: Model Based Avionics Design
- AOCS: Smart AOCS & GNC Elements

# Scope of the CoRA activities.



**Candidate sensors:**

- FaintStar-based Star Tracker
- MEMS-based IMU
- Sun Sensor on a chip
- Navigation on a chip

**Applications:**

- LEO Earth Observation
- LEO Telecom
- Exploration
- In-orbit servicing

**Concepts:**

- SAVOIR-SAFI
- Spacewire AOCs prototyping
- Time and Space partitioning

A: scope of the SMART AOCs & GNC ELEMENTS ACTIVITY

B: scope of the RECONFIGURABLE DATA HANDLING CORE

C: scope of the MODEL BASED AVIONICS DEVELOPMENT

The key objectives of this activity are:

- A. To **analyze and select one candidate AOCS/GNC configuration**. The selected configuration shall implement AOCS/GNC functional chain with ***flight representative sensors and actuators in a compact and reconfigurable way***.
- B. To demonstrate the feasibility of the selected configuration by **prototyping with breadboard and testing them**, focusing on interfaces and functional aspects exploiting at maximum extent the avionic platform capabilities (***high computation performance and re-configurability***).

**Space Rider** aims to provide Europe with an affordable, independent, reusable end-to-end integrated space transportation system for routine access and return from low orbit. It will be used to transport payloads for an array of applications, orbit altitudes and inclinations. Space Rider is a reusable orbital vehicle designed to fly up to 6 times to carry out Earth Observation, Microgravity, Telescope and Rendez-vous missions.



The nominal mission data are

Mission duration: 2 Months  
Mass (OSM+RM): 4100kg  
Orbit altitude: 400 Km  
Orbit Inclination: 5°  
Attitudes: Nadir & Inertial

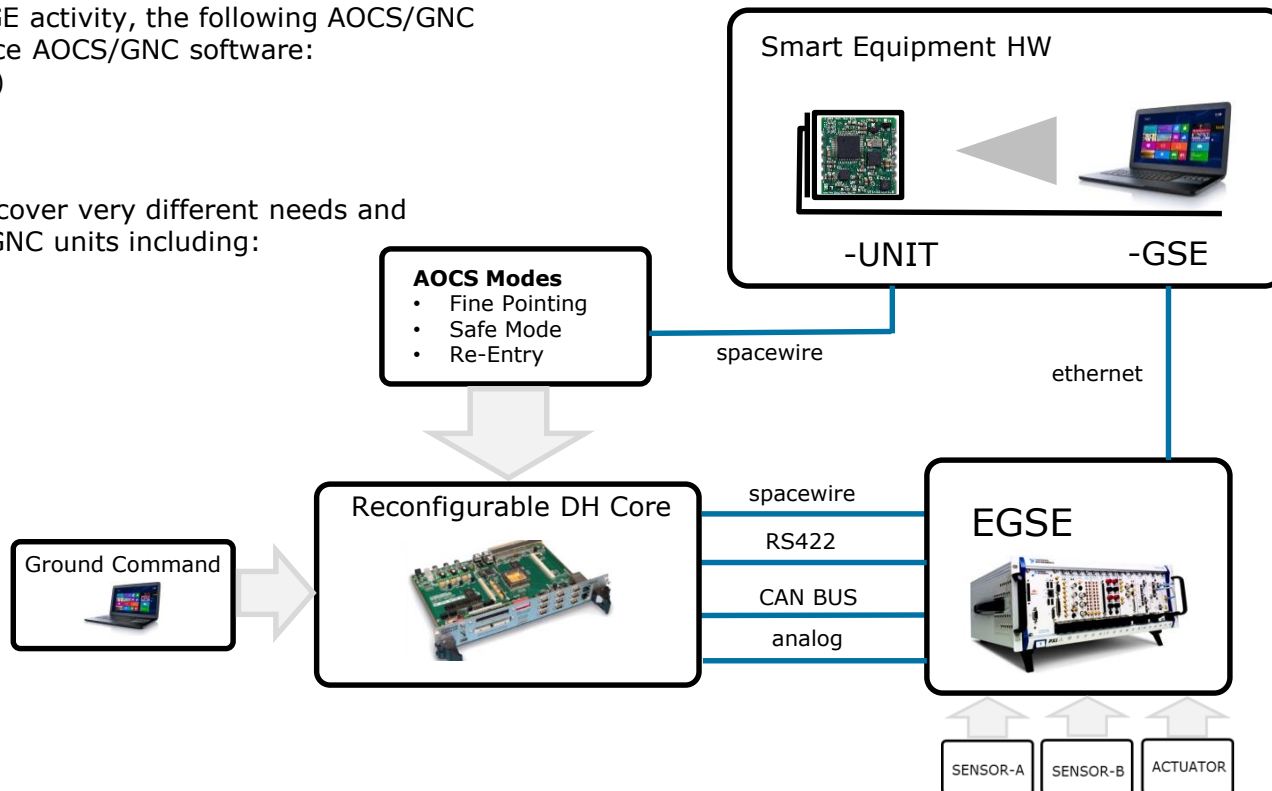
# CoRA-Smart AOCS/GNC Elements

In the frame of the CORA-SAGE activity, the following AOCS/GNC modes will be used as reference AOCS/GNC software:

- Inertial Pointing Mode (IPM)
- Re-Entry & TAEM (REM)
- Safe Mode (SFM)

This mode selection allows to cover very different needs and requires a large set of AOCS/GNC units including:

- Star Trackers
- GNSS
- INS
- Sun Sensors
- Gyroscopes
- Fluid Air Data System
- Reaction Wheels
- Thrusters
- Entry Elevons



# CoRA-RDHC - Activity objectives

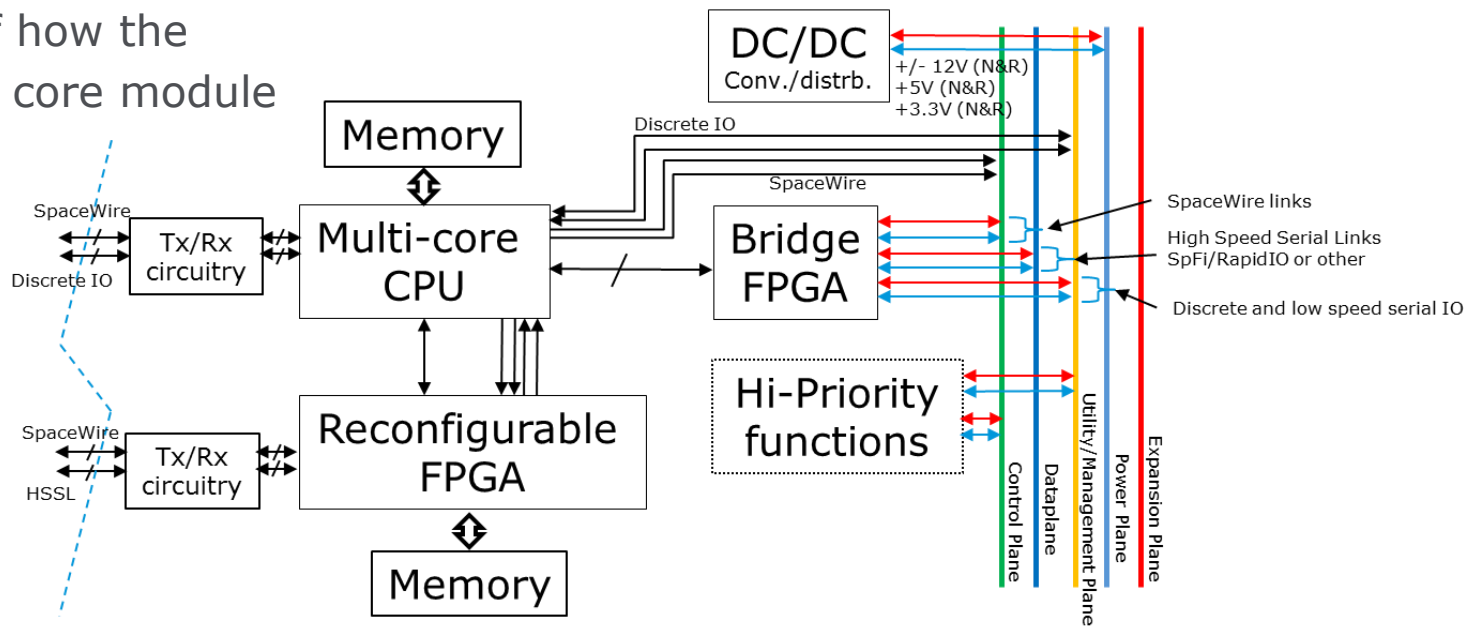


- Development of an **elegant breadboard (EBB)** module of a **compact reconfigurable data handling core (CRDHC)**.
- Shall be inspired by the **SAVOIR Functional Reference Architecture**.
- Shall be a **Modular System**.
- **Reconfigurable FPGAs used for bespoke processing (AOCS)**.
- Shall have a **clear path to achieve space qualification**.
- **Development of boot SW and BSP** for the CRDCH EBB,
  - For **low level communication between processor to companion FPGA**
  - For **communication interfaces** towards external sensors and actuators.
  - Include a subset of **PUS services**
- Support the deployment of the **compact reconfigurable avionics testbed** as part of the **ESTEC Avionics laboratory**.
- All HW and SW pertaining to the design of the EBB shall be fully **ESA owned**.
  - It's reference design to be used for future module developments.



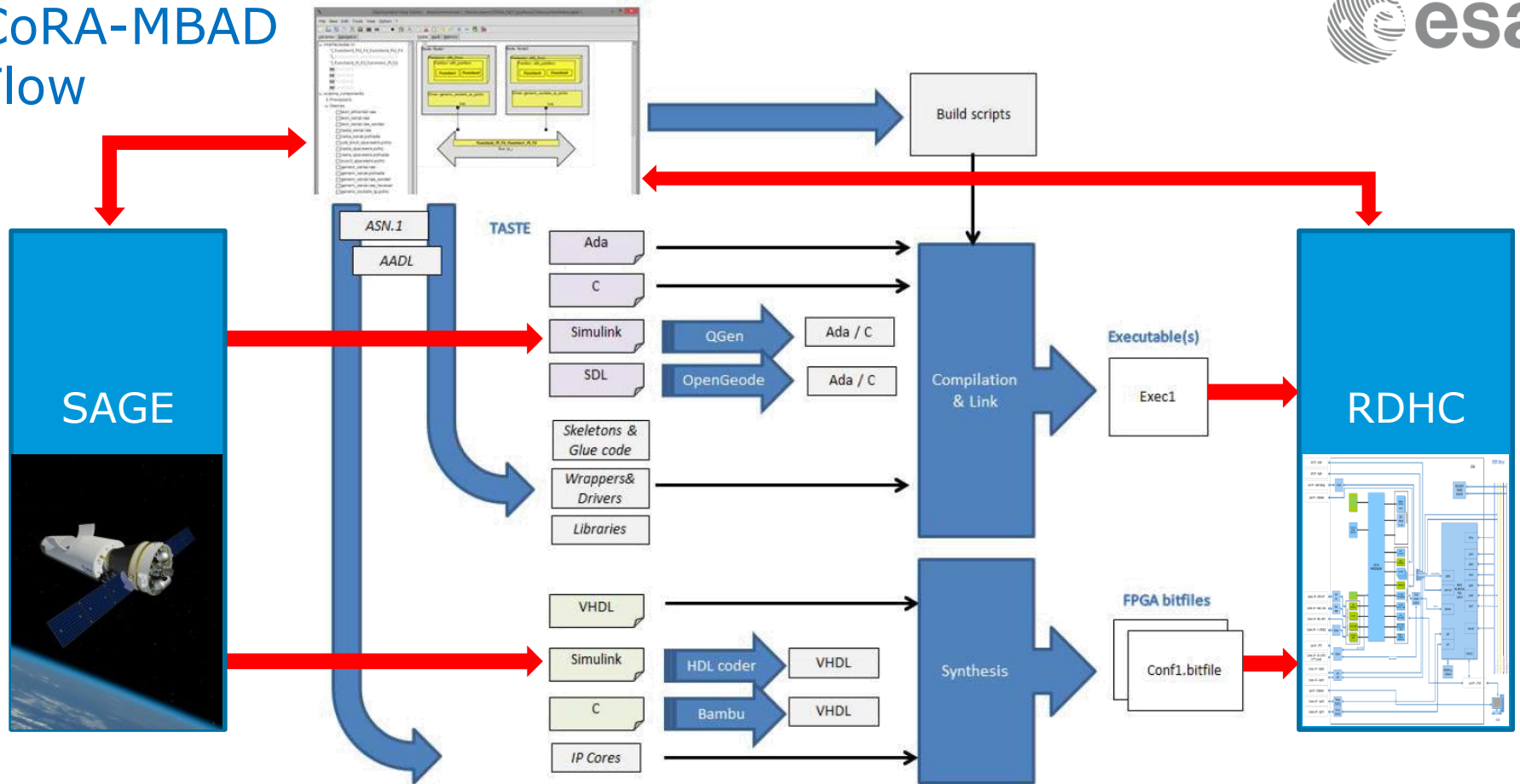
# CoRA-RDHC - Potential architecture

A high level VITA 78.1 implementation of how the reconfigurable DH core module may be implemented



CRDHC block diagram (likely to change)

# CoRA-MBAD Flow





# CoRA-MBAD Toolchain



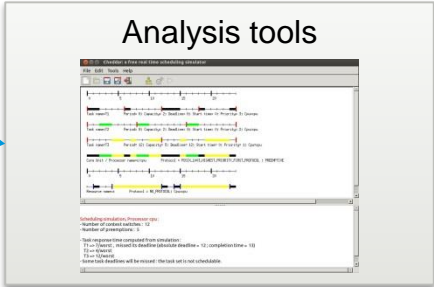
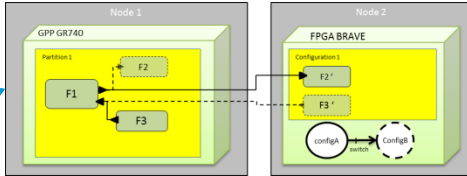
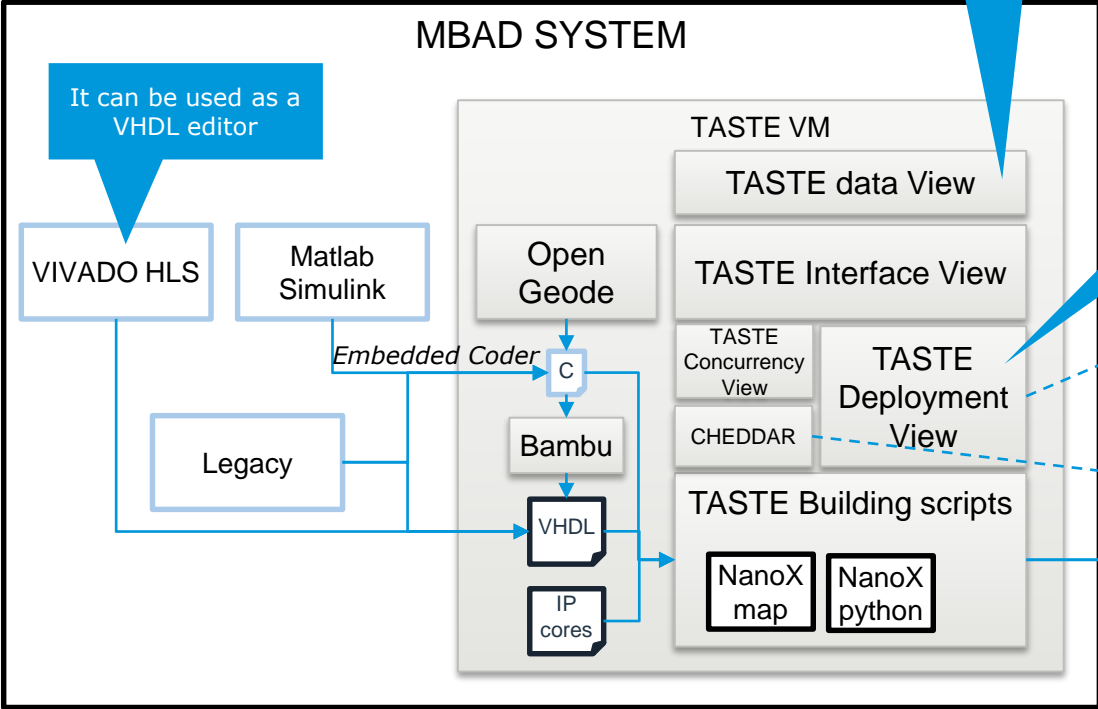
Allows to define FPGA configurations IDs

Allows to define HW architecture (CPU, FPGA, communication drivers, ...) and perform Function allocation

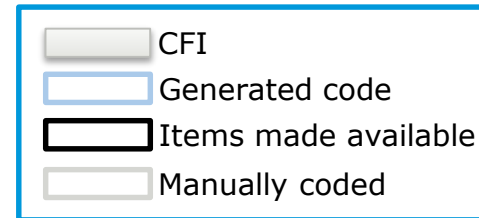
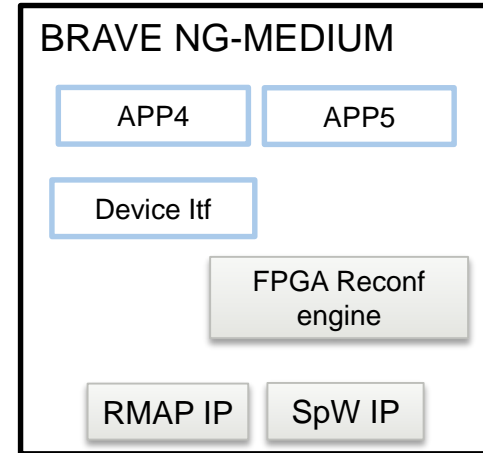
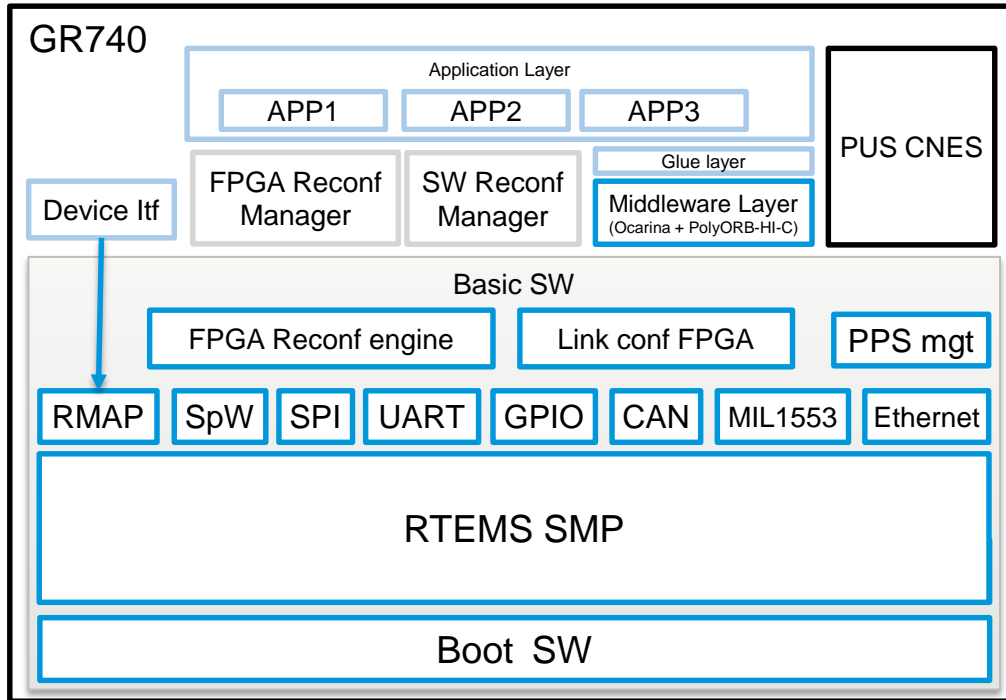
It can be used as a VHDL editor

Legend for tool types:

- Open Source Tool (light grey box)
- Commercial Tool (blue box)
- Items made available (black border box)



# CoRA-MBAD Target environment

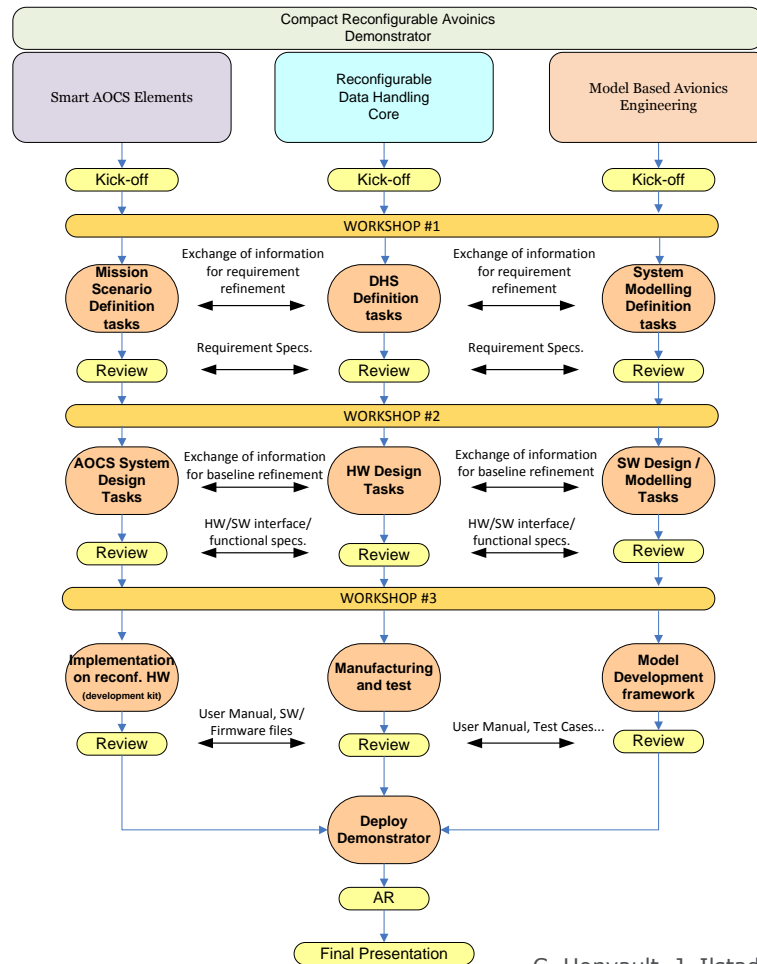


CoRA – This is just the beginning...

Thanks for your attention...



# Organisation



# Concept of development

