AVIONCS Architecture: SAVOIR and Beyond

Introduction and Status of SAVOIR

On behalf of Savoir Advisory Group
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ESTEC, 2-Nov-2010

Motivation for the SAVOIR initiative

Improve the way we deliver Space Systems (cost & schedule) by

- **Pre-developed Building Blocks based on**
  - **Well defined Specification & Interfaces based on**
    - **An agreed Reference Architecture**

Terms used

- **Architecture**:
  IEEE Std 1471: "The fundamental organization of a system embodied in its components, their relationship to each other, and to the environment, and the principles guiding its design and evolution"

- **Standards:** Refers to an established norm or requirement issued by a recognised standardisation organisation (as ECSS, CCSDS or similar)

- **Reference Architecture**: An abstract representation of an architecture allowing to identify BBs and interfaces. The reference architecture is an agreed basis and a template solution for a particular domain, known and used by various stakeholders.

- **Avionics System Topology** : Representation of a reference architecture with modules/units/interconnects depicted in a representative manner: e.g. box/unit level, centralised or decentralised with redundancy and cross- strapping

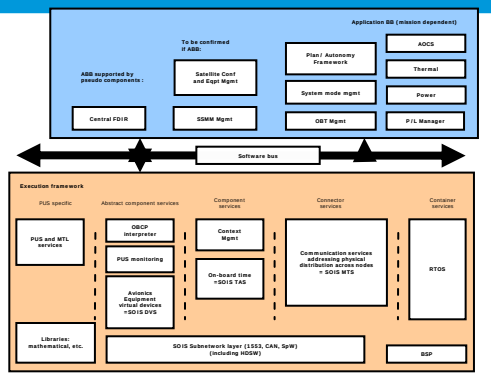
- **Generic specification / item**: specification/item that covers an extended domain of applications, (may be applicable after tailoring).
  - Generic specifications are functional spec's and may includes constraints as applicable standards, interface requirements and performance requirements

- **Canonical specification / item**: specification/item based on a generic specification (may be tailored) that respects SAVOIR rules/recommendations.

Terms used - software

- **Software reference architecture**
  A set of architectural design principles and a mapping of the usual functions implemented by the software onto the components and the execution platform.

- **Functional architecture**
  Focus is on the system functionalities to be implemented and on the relation to their environment
- A functional architecture is built, independently from the issues brought by the integration on an execution platform.



Set of generic spec's

- **Physical architecture**
  The Physical architecture describes the processing nodes of the system (i.e. on-board computer), sensors and actuators, the network topology (buses/point-to-point links/serial lines) that interconnects them and the communication protocol used by the physical communication layers.

Products – Building blocks

SAG
Space Avionics Open Interface aRchitecture (SAVOIR) Advisory Group

SAVOIR Advisory Group

Terms of Reference

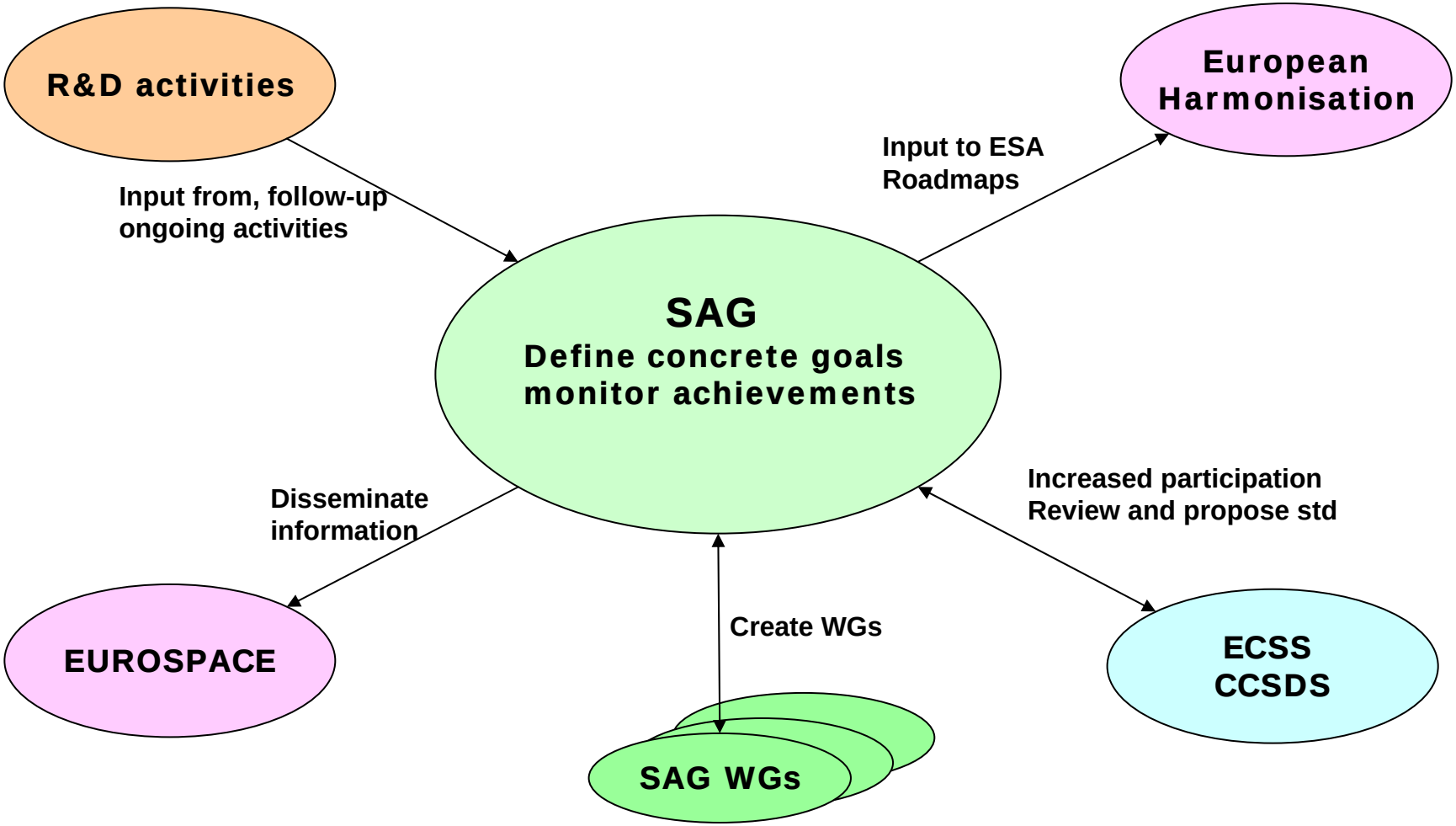
- To enhance the coherence in the area of avionics of all initiatives (e.g ECI) and organizations (e.g Eurospace) through a shared knowledge of the information by all main stake-holders of the Avionics field.

- To get a consensus with all stake-holders on development priorities and standards evolution

- To share as far as possible a common vision of future avionics architecture such that avionics components road-maps can have the greatest support from the Industry

- To bring the full visibility of what is going on in the area of avionics developments performed by the Agencies towards the Industry

SAVOIR Advisory Group: Tasks and Responsibilities



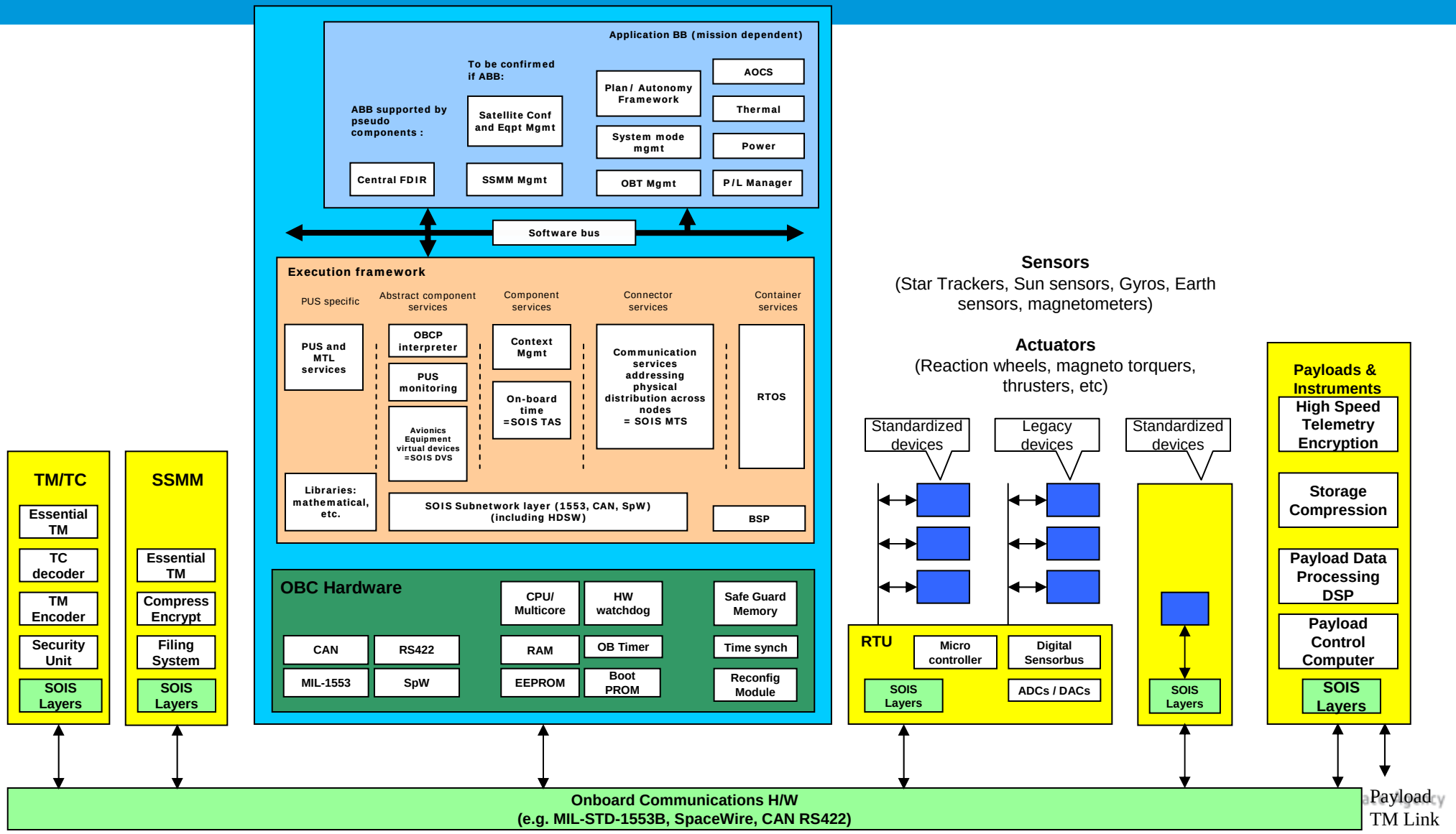
SAVOIR Main Goals

- Streamline the development of avionics systems: increase cost-efficiency and reduce development time
- Stimulate innovation in onboard avionics functionality (reducing effort for low added-value, low-level elements)
- Standardise avionics: building blocks and standard interface definitions
- Maximise synergy between ongoing initiatives at ESA, National Agencies and industry and help concentrate all the efforts towards the shared objectives
  - Software architectures, SW Engineering Tools and methods, System Composition
  - Onboard communications, processors, data systems, SOIS std
  - AOCS sensor and actuator harmonisation
-

SAVOIR Advisory Group: Membership

- SAG:
  - Space Agencies:
    - ESA — P. Armbruster, A. Benoit, K. Hjortnaes, J. Miró
    - CNES — P.van Troostenberghe
    - DLR — T. Wolf
  - System integrators:
    - TAS — J. Busseuil
    - Astrium — T. Duhamel
    - SSC — M. Carlqvist
    - OHB — B. Brünjes
  - SW and Eq. Suppliers
    - RUAG Space — T. Hult
    - Terma — C. Jorgensen
    - Selex Galileo — F. Boldrini
    -
- SAG Working Groups: Open also to other space Agencies, system integrators and avionics software or equipment suppliers that can contribute to the WG objectives

Conceptual Reference Architecture and Building Blocks



Building Blocks Definition

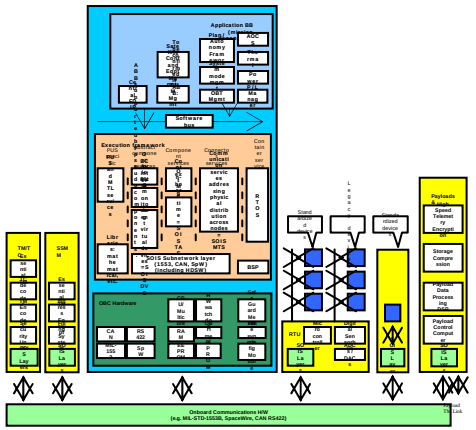
- A BB is an element of the Avionics, either HW or SW, that:
  - Has a clear, documented function and open interfaces
  - Meets defined performance, operation and other requirements
  - Is self-contained so as to be compatible with utilization at higher integration levels, e.g board, equipment, subsystem
  - Has a TRL and quality level which can be assessed
  - Is applicable in an envelope of well defined physical and software environment
  - Results from a process that can be repeated with guarantees
  - Is worth developing, ie. utilization is envisaged at least for the bulk of the ESA missions
  - Is designed for reuse by different users, in different projects (it should be configurable)
  - Can be made available off-the-shelf, under defined conditions

SAG latest work plan

- Architectures :
  - Created WG on Software Architecture
  - Incorporated WG Interface with Time and Space Partitioning (IMA)
- Interfaces
  - Created WG on AOCS sensors and actuators I/F WG
  - Follow up CCSDS SOIS
  - Inputs on ECSS PUS std update
- Building Blocks: priorities
  - First list with priorities: March 09
  - Additional BBs proposed
  - Consolidation: October 09
  - SAG BB Priorities document by end 2009
- R&D: Inputs to Harmonisation Dossiers
  - Avionics Embedded Systems
  - Onboard Software

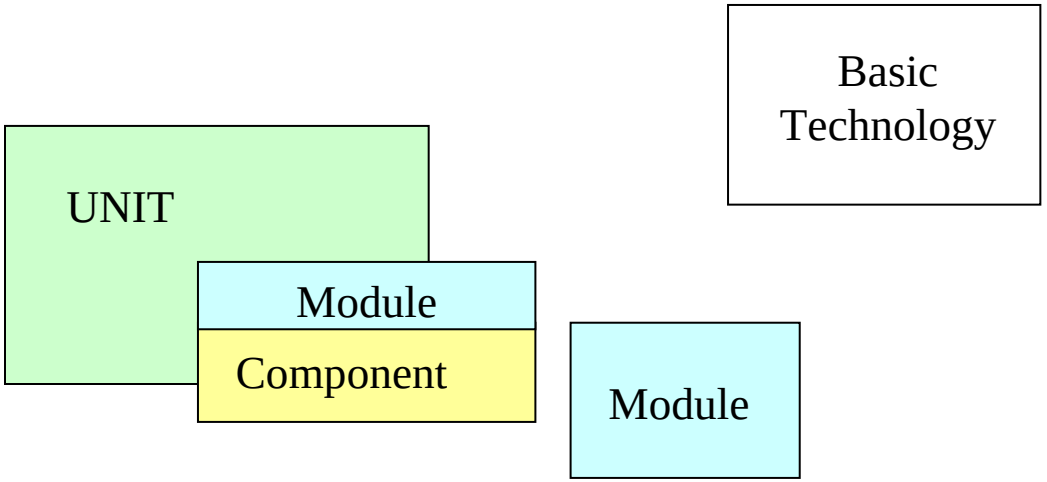
SAVOIR, output 2010

- Avionics Reference Architectures concept (satellite platforms/payloads); common vocabulary and shared principles
- Software Reference Architecture (Savoir-Faire WG): architectural principles,component model, execution platform [COrDeT]
- Sensor/actuators electrical interface (in particular RS422 protocol)
- Harmonisation roadmap and TECNET plan
- List of Building Blocks with priorities
  - Some GSTP5 Element 2 activities



Building Block priorities

- BB have been categorized by the SAG as follows



- BB prioritisation criteria:
  - The BB complies to the BB definition agreed by the SAG
  - The BB can be used in a wide range of missions, i.e. has a potential for being used in “core” European missions, both institutional and commercial.
  - There is a need to initiate an action to develop/qualify new/existing BBs
  - There is a clear demand for the BB (business case) confirmed by a majority of SAG members
  - Is compatible with the HW and SW reference architectures being defined within SAVOIR

SAG Sub- working groups

- AOCS Sensors and Actuators I/F WG

- SAVOIR-FAIRE: Fair Architecture and Interface reference Elaboration

AOCS Sensors and Actuators I/F WG

- Mandate
  - Triggered from the AOCS sensors and Actuators Harmonisation processes
  - Make proposals to rationalise the Power, Data and Timing interfaces for AOCS equipments within Europe.
- Input:
  - Available products
  - Industrial inputs
- Output:
  - Survey results
  - Technical report with survey results analysis and recommendations
- Membership
  - Agencies (CNES, ESA)
  - Primes (Astrium, TAS)
  - Equipment suppliers (Terma, GA, JenaOptronik, Bradford Engineering, Lusospace, SEA, RUAG, Sodern)

Interim Outputs
- Data Interface market survey

– Equipment Impacts (summary)

	Analogue	MIL-1553	RS-422	SpW	CAN
Recurring cost impact	1.7	2.6	3.5	3.5	3
EEE parts issues	4.25	2.1	3.8	5	4.2
Impact on future development	1.2	2.9	2.6	4	3.9

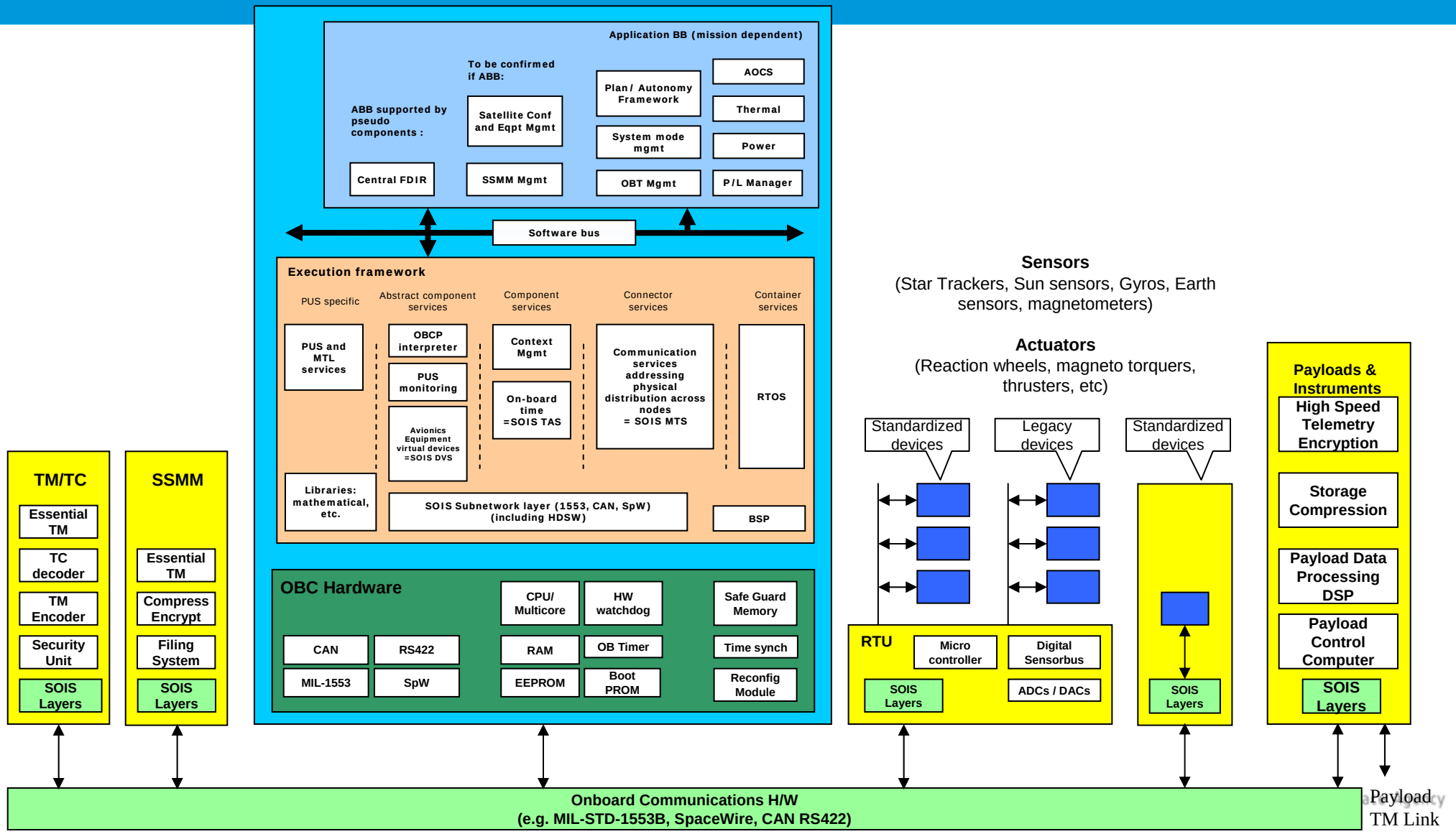
– For most units analogue i/f is not an attractive solution.
– SpW, CAN and RS-422 all have a generally positive impact on the units.
– RS-422 biggest perceived problems are data rate and lack of established protocol
– MIL-1553 is ‘acceptable’ but not desirable in terms of equipment impacts (but has market and system benefits)

– Main EGSE/ Other cost drivers is support of multiple i/f rather than driven by any one particular i/f

SAG Software Architecture Working Group

- Mandate
  - The WG shall elaborate the flight software architecture and related interfaces as to allow the implementation of interface standards and software BBs to fulfil the objectives of the SAVOIR initiative, namely to progress towards standardisation in the avionics development.
- Input:
  - Previous space R&D activities, i.e. Cordet, and lessons learnt from non-space activities (e.g. Autosar)
- Output:
  - Definition and representation of a SW reference architecture
  - Support identification of priorities for SW BB
  - Contribution to Harmonisation dossier in Onboard SW
  - Disseminate results: presentation ADCSS, DASIA, etc
- Membership
  - Agencies (CNES, DLR, ESA)
  - Primes (Astrium, TAS, SSC)
  - Software suppliers (GMV, Terma, SSF, SciSys)

Conceptual Reference Architecture and Building Blocks



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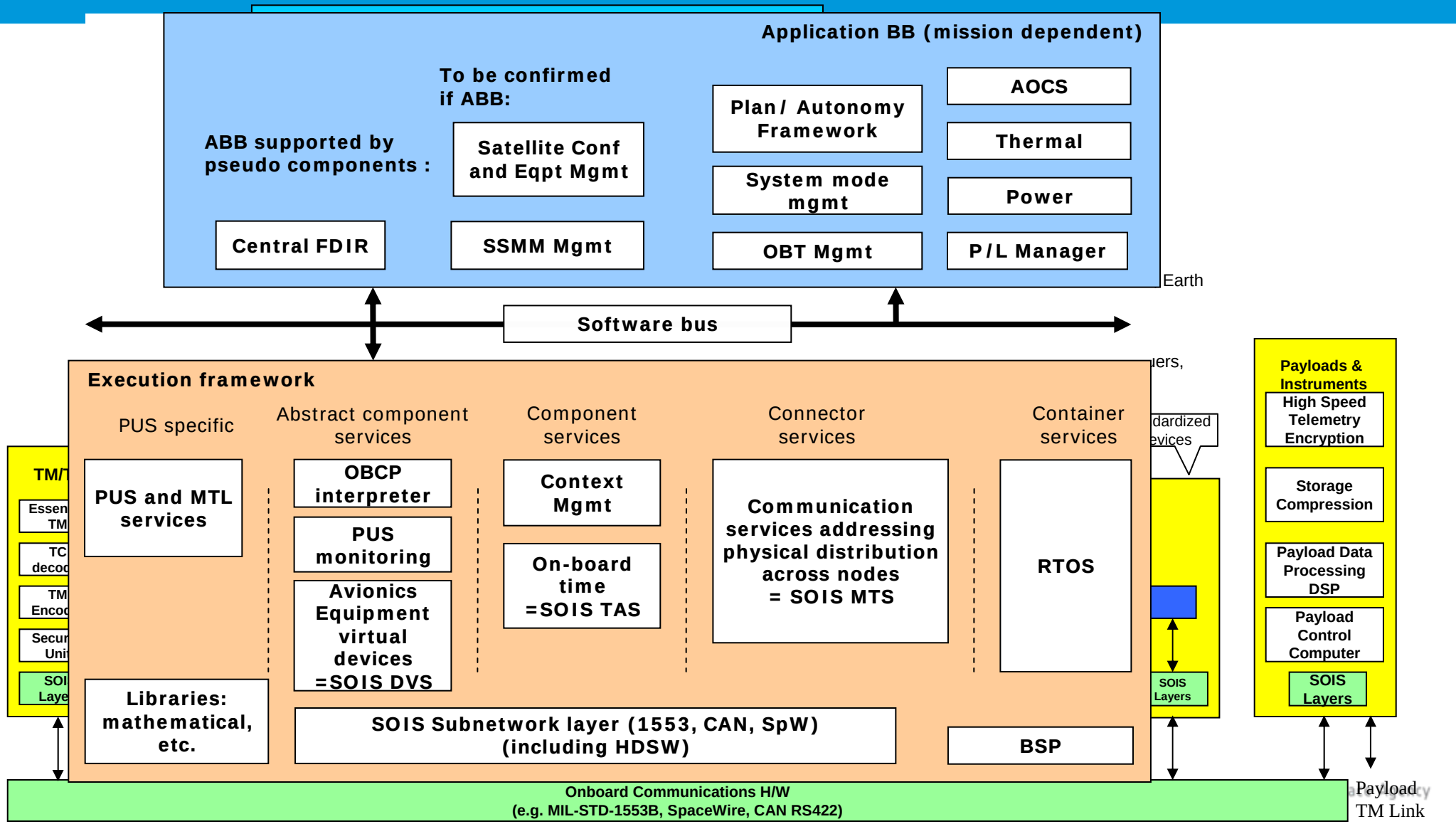
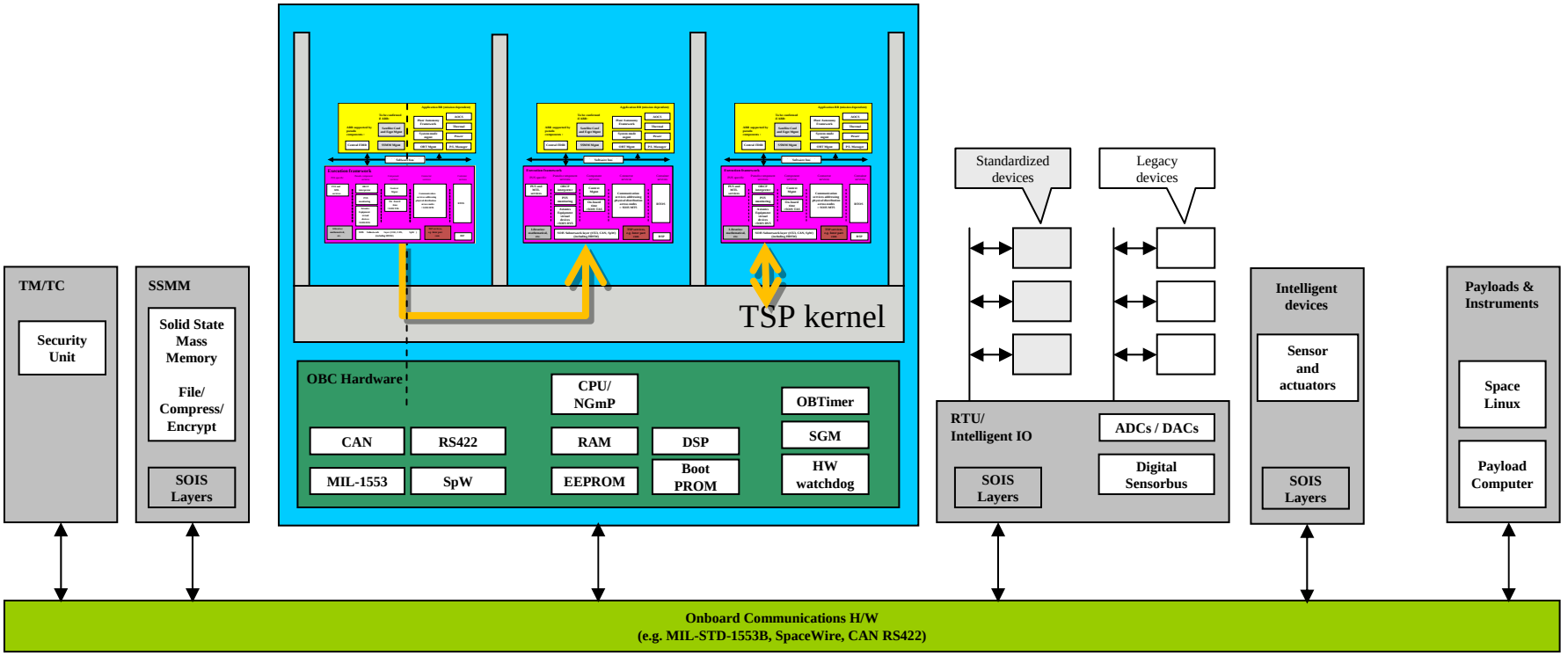
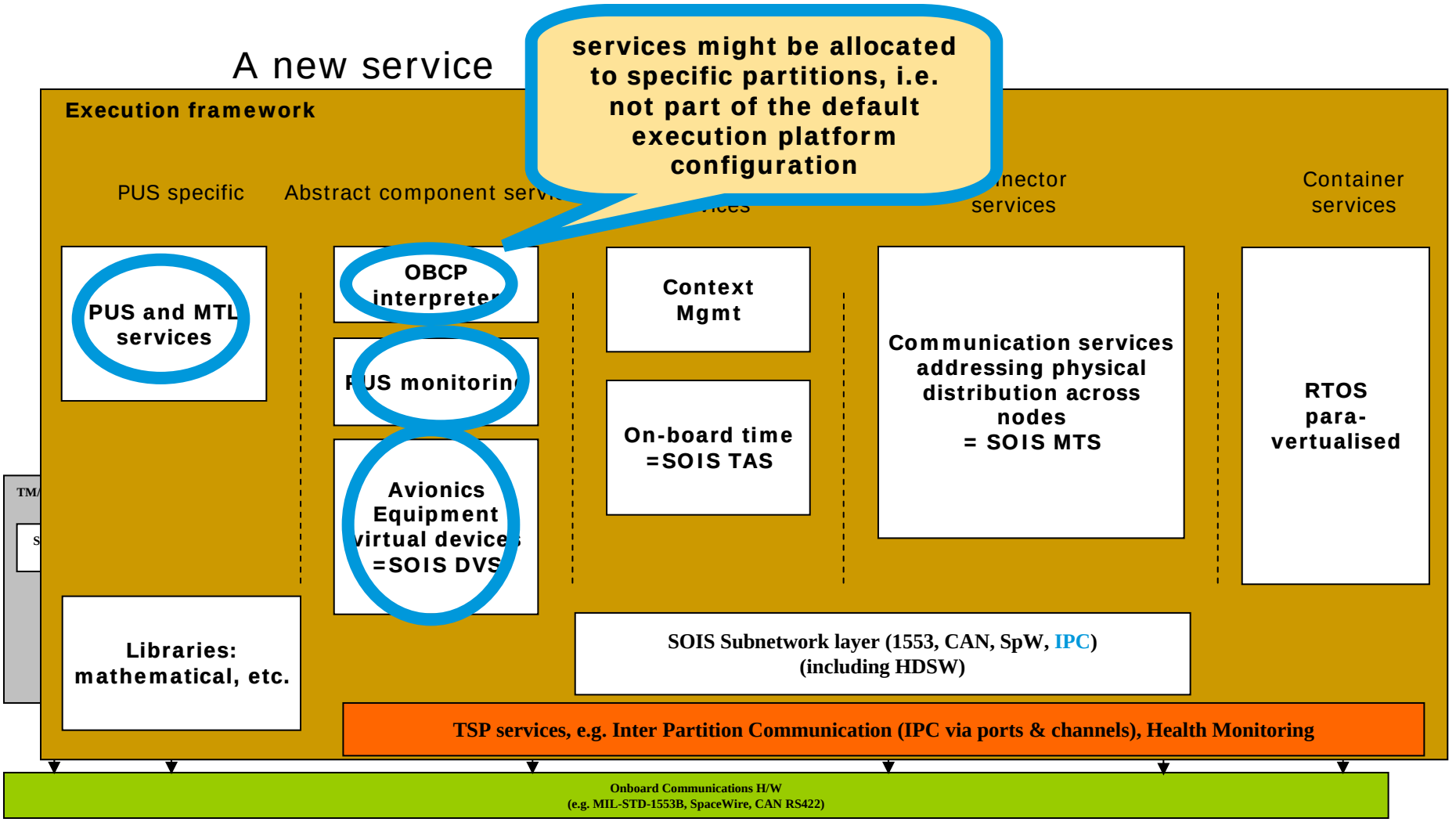


Time & Space Partitioning and Software Reference Architecture

A new service
in the execution platform…

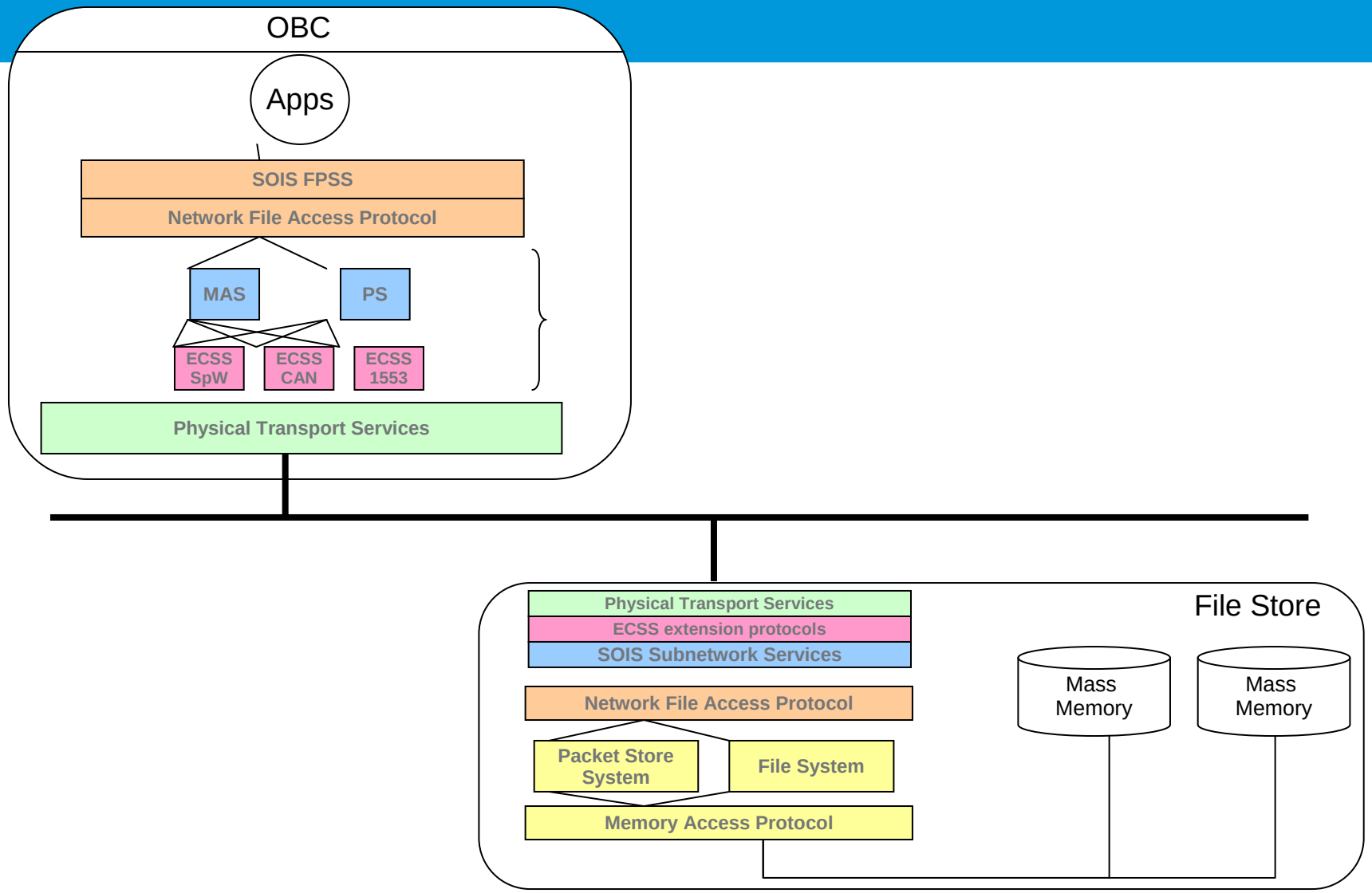


Time & Space Partitioning and Software Reference Architecture

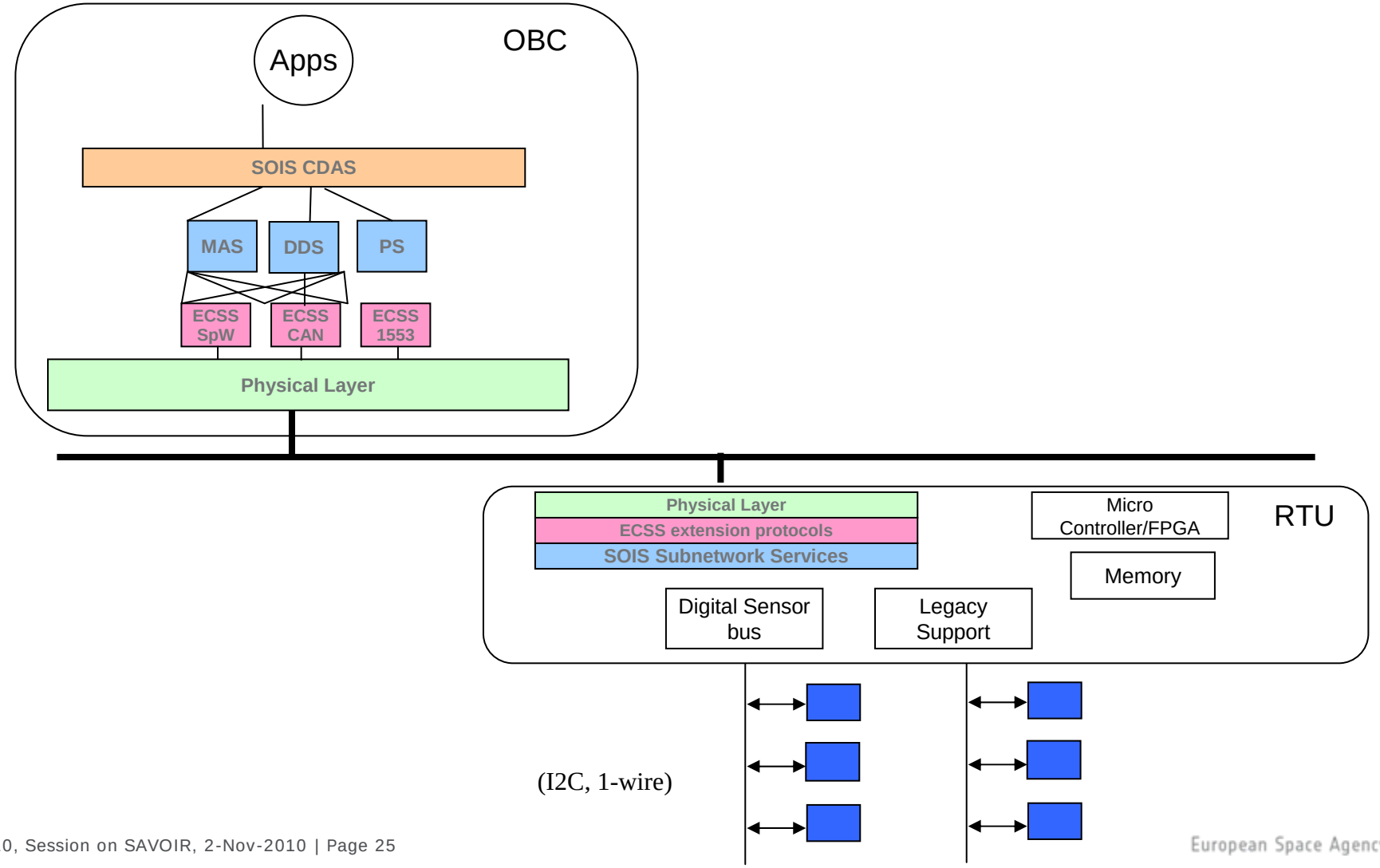


other investigations
- SOIS

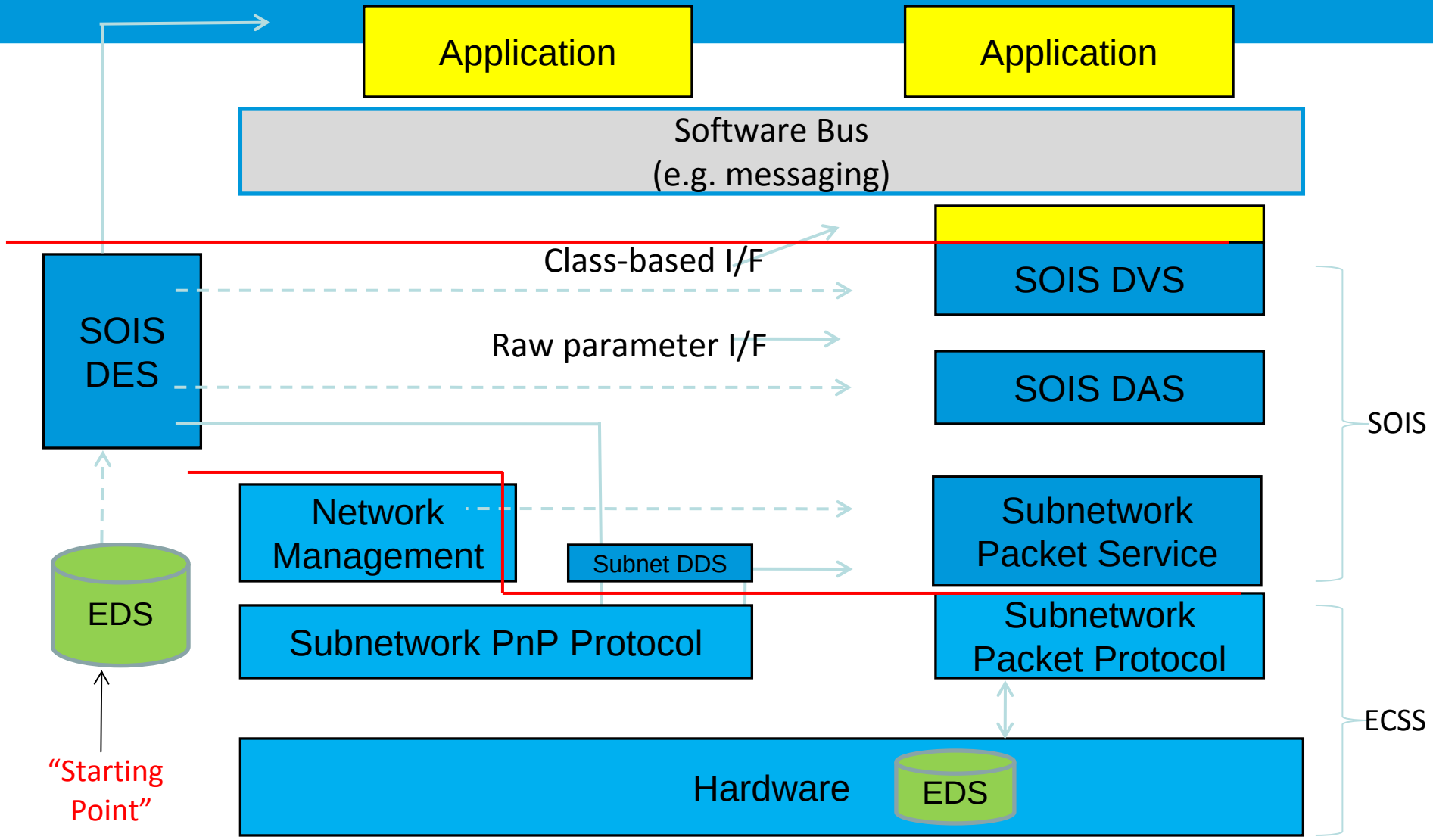
SSMM Building Block Prototype



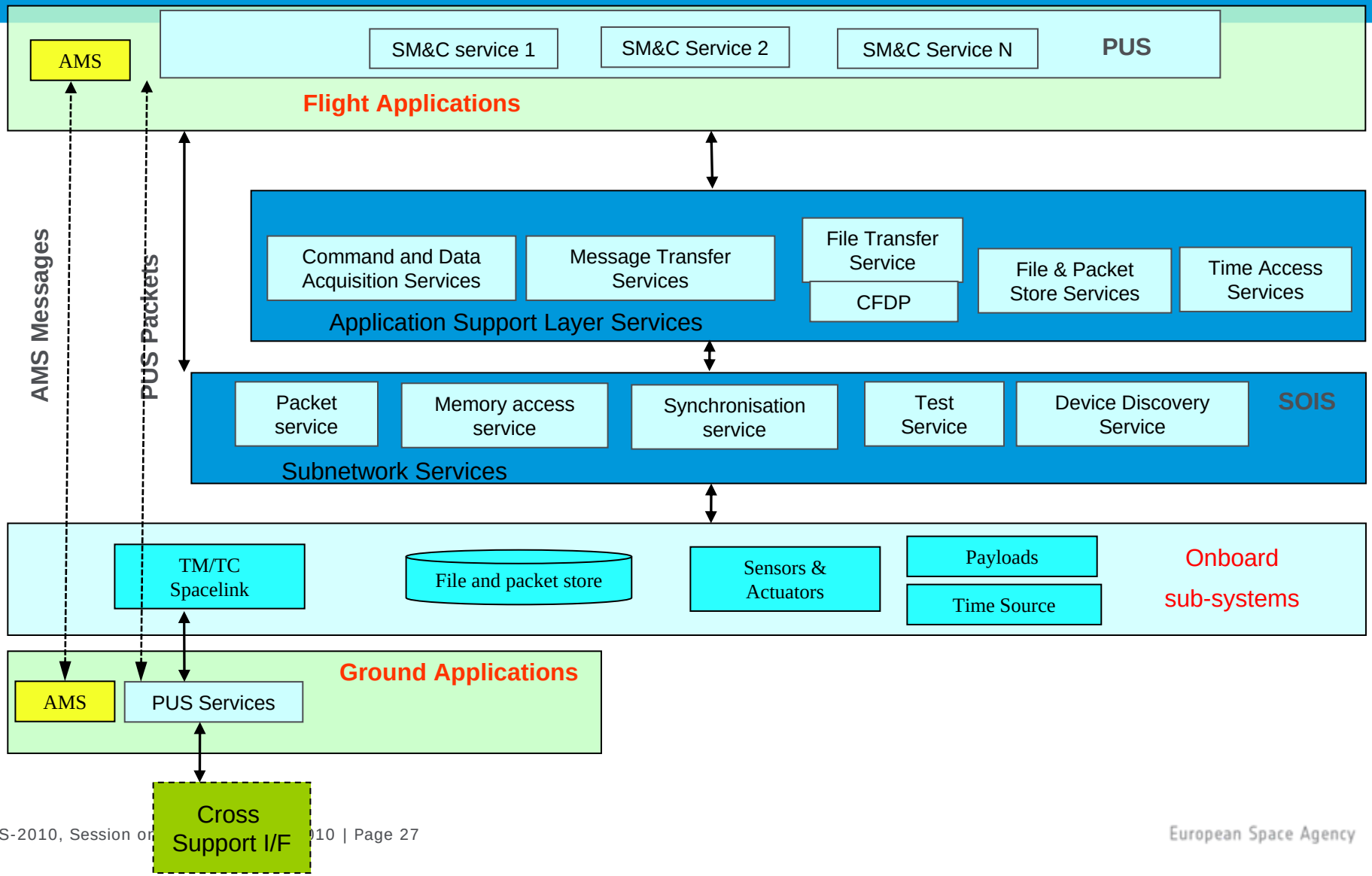
RTU Building Block Prototype



Spacecraft Plug-and-Play Architecture



SOIS, PUS, AMS and SM&C – Relationships



SAVOIR, next steps

- Refinement/ and modelling of reference architecture (industrial contract – AADL model)
- Sensor/Actuator functional interface
  - ➔ extension of Savoir-Faire WG to include AOCS experts
- Priority investigations – Consolidation of Reference architecture (frame contract under RUAG)
  - Consolidation of reference architecture.
  - Space-Ground Interface Savoir definition
  - Payload Interfaces
  - OBC interface and reference specification
  - Mini RTU specification and interface

- Development of Roadmap for implementation of savoir in project (industrial support contract)

- Other investigations: Security, Power Distribution (for centralised architectures)
- Roadmaps and plans
  - Structured Documentation and Standardisation approach
  - Roadmap for BB qualification, distribution, IPR, maintenance, sustaining engineering
  - Propose interface standardisation activities/list
  - Propose prototyping activities
- Monitor avionics activities