SOIS Evaluation by the Primes

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Software Reference Architecture - Focus on the Execution Platform
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Outline

- **SAVOIR Communication Architecture**
- **SOIS and ECSS standards**
- **Feedback and recommendations**
- **Conclusions**

SAVOIR Communication Architecture
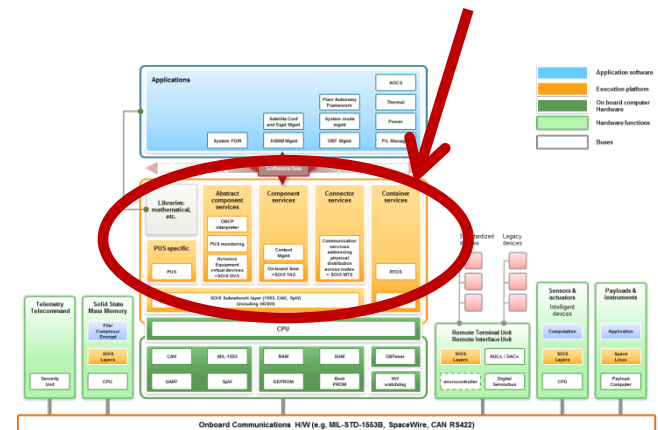
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Savoir Communication Architecture

- 3 parallel GSTP activities with:
  - Airbus Defense and Space – Toulouse
  - OHB System – Bremen
  - Thales Alenia Space – Cannes

Objectives:

- **Evaluation of SOIS and ECSS standards**

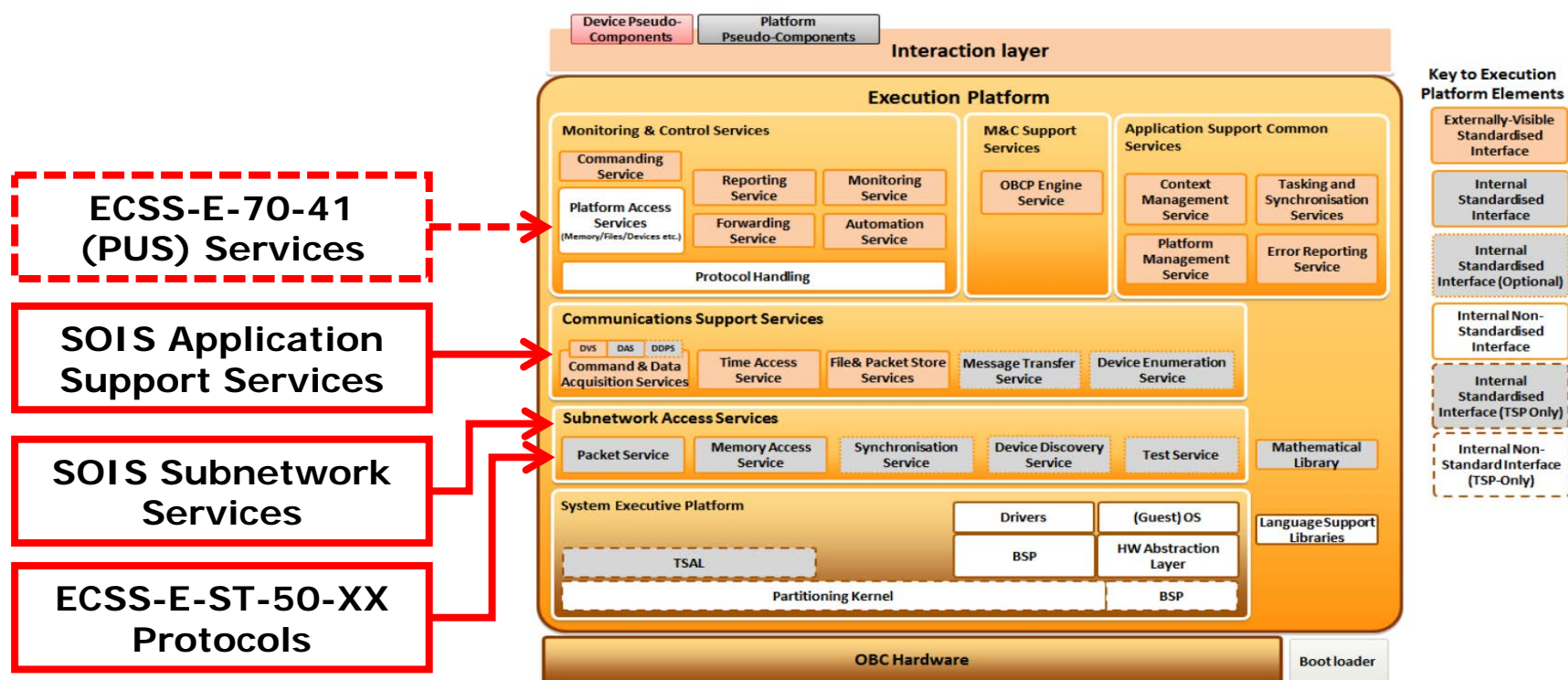- Integration of a subset of the services into existing proprietary FSW architecture

Execution Platform

SOIS and ECSS standards

The communication architecture relies on CCSDS and ECSS standards

It's a layered architecture!

The SOIS and ECSS standards 2/2

- CCSDS 850.0-G-2 December 2013, Green Book - Spacecraft Onboard Interface Services
- CCSDS 851.0-M-1 December 2009, Magenta Book – SOIS Subnetwork Packet Services
- CCSDS 852.0-M-1 December 2009, Magenta Book – SOIS Subnetwork Memory Access Services
- CCSDS 853.0-M-1 December 2009, Magenta Book – SOIS Subnetwork Synchronisation Services
- CCSDS 854.0-M-1 December 2009, Magenta Book – SOIS subnetwork Device Discovery Services
- CCSDS 855.0-M-1 December 2009, Magenta Book – SOIS Subnetwork Test Services
- CCSDS 871.0-M-1 March 2013, Magenta Book – SOIS Device Access Service
- CCSDS 871.1-M-1 November 2012, Magenta Book – SOIS Device Data Pooling Service
- CCSDS 871.2-M-1 March 2014, Magenta Book – SOIS Device Virtualization Service
- CCSDS 871.3-M-1 October 2014, Magenta Book – SOIS Device Enumeration Service
- CCSDS 872.0-M-1 January 2011, Magenta Book – SOIS Time Access Service

- CCSDS 873.0-M-1 September 2012, Magenta Book – SOIS File and Packet Store Service
- CCSDS 875.0-M-1 November 2012, Magenta Book – SOIS Message Transfer Service
- ECSS-E-ST-50-13C November 2008, Space Engineering – Interface and communication protocol for MIL-STD-1553B data bus onboard spacecraft
- ECSS-E-ST-50-15C DIR1 December 2013, Space engineering - CANBus extension protocol
- ECSS-E-ST-50-12C, July 2008, Space Engineering - SpaceWire Links, nodes, routers and networks
- ECSS-E-ST-50-51C, February 2010, Space Engineering - SpaceWire protocol identification
- ECSS-E-ST-50-52C, February 2010, Space Engineering - SpaceWire Remote memory access protocol
- ECSS-E-ST-50-53C February 2010, Space Engineering - SpaceWire CCSDS packet transfer protocol
- ECSS-E-ST-70-41A January 2003, Space Engineering – Ground Systems and Operations – Telemetry and Telecommand Packet Utilization

CCSDS publications are available at: www.ccsds.org

ECSS publications are available at: www.ecss.nl

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Feedback and recommendations

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Command & Data Acquisition Services - Attributes

Device Access Service (DAS)

– abstracts from the protocol required to control the device

– abstracts from the type of communication service (i.e. memory access, packet-base) required to access the device

– abstracts from time constrains strictly related to the device specific access protocol
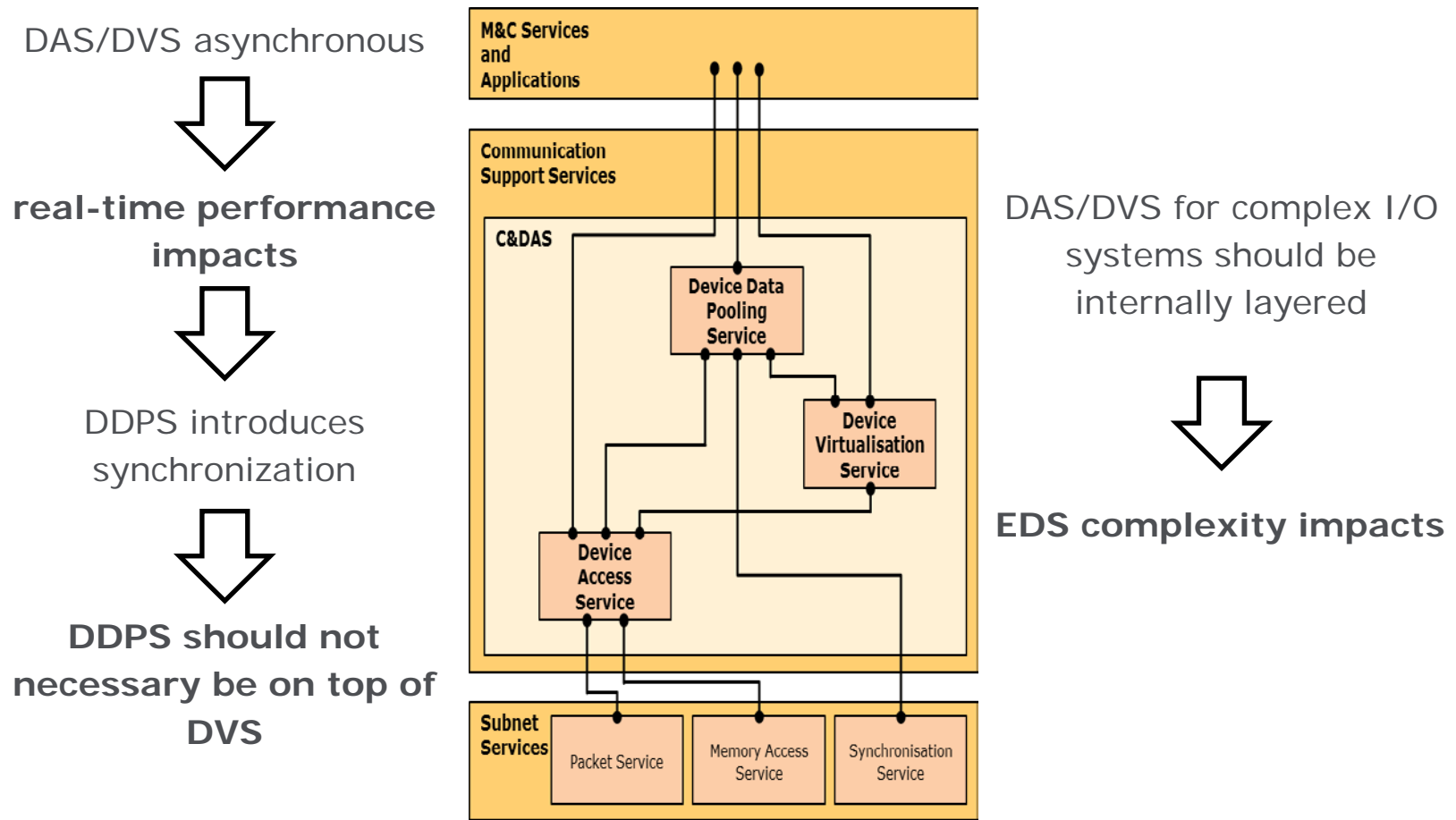
Device Virtualisation Service (DVS)

– adds ontology to the raw command and data information related to devices

– can provide a uniform interface for each class of devices, independent from their actual implementation

Device Data Pooling Service (DDPS)

– decouples device physical access from device data consumption by the applications

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DAS/DVS asynchronous

⬇

real-time performance impacts

⬇

DDPS introduces synchronization

⬇

DDPS should not necessary be on top of DVS

DAS/DVS for complex I/O systems should be internally layered

⬇

EDS complexity impacts

Time, Files, Packet Stores and Message Transfer - Attributes

Time Access Service (TAS)

– abstracts from the mechanisms required to access the on-board reference time and to handle time alarms.

Message Transfer Service (MTS)

– provides a high level and uniform mechanism to communicate between software applications within the spacecraft.

File & Packet Store Service (FPSS)

– provides a standardised interface to mass memory file and packet stores

– abstracts from the implementation details related to the mass memory file systems.

Files, Packet Stores and Message Transfer - Feedback

Time Access Service

- TAS is at the same level of other Communication Support Services, but **it should be usable by all SOIS services**

Message Transfer Service

- Not easy to understand and use due to the organization of the standard: MTS being a profile of Asynchronous Message Service.

- Existing FSW architectures have their own messaging services, so the introduction of MTS is not a priority

File & Packet Store Services

- Good match between CNES File Management System and SOIS FPPS

- New PUS Service 15 is simplified and can be mapped to SOIS Packet Store Services

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Device Enumeration and Discovery Services - Attributes

Device Discovery Service (DDS)

– provides mechanisms to discover and configure devices connected to a subnetwork

Device Enumeration Service (DES)

– provides mechanisms to handle units redundancy

– provides the means to configure the Command & Data Acquisition Services

# Device Enumeration and Discovery Services - FDIR

DES should help in on-board FDIR, but **the interactions with other services are not standardized**

No consensus on the usage

→ **to extend service capabilities, i.e. including equipment status information**

or...

→ **to leave the FDIR in full control of the on-board Application SW**

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Subnetwork Services - Attributes
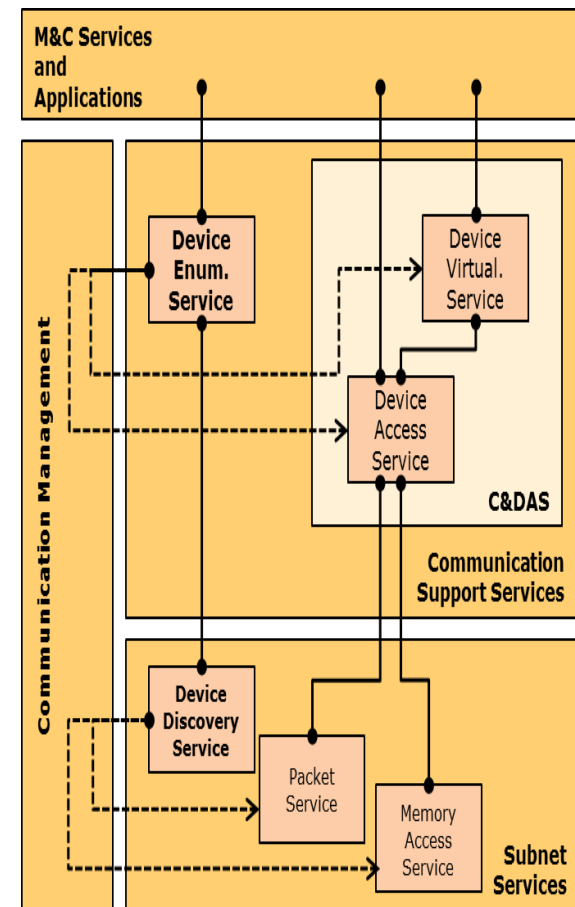
Packet Service (PS)

Memory Access Service (MAS)

Synchronisation Service (SS)

- abstract from the physical location (within the spacecraft) of the unit to be accessed

- abstract from the datalink protocol required by a specific communication media to access a unit

- abstract from time constrains strictly related to the specific communication media used to access a unit

- abstract from the addressing scheme required by a specific communication media to identify a unit.
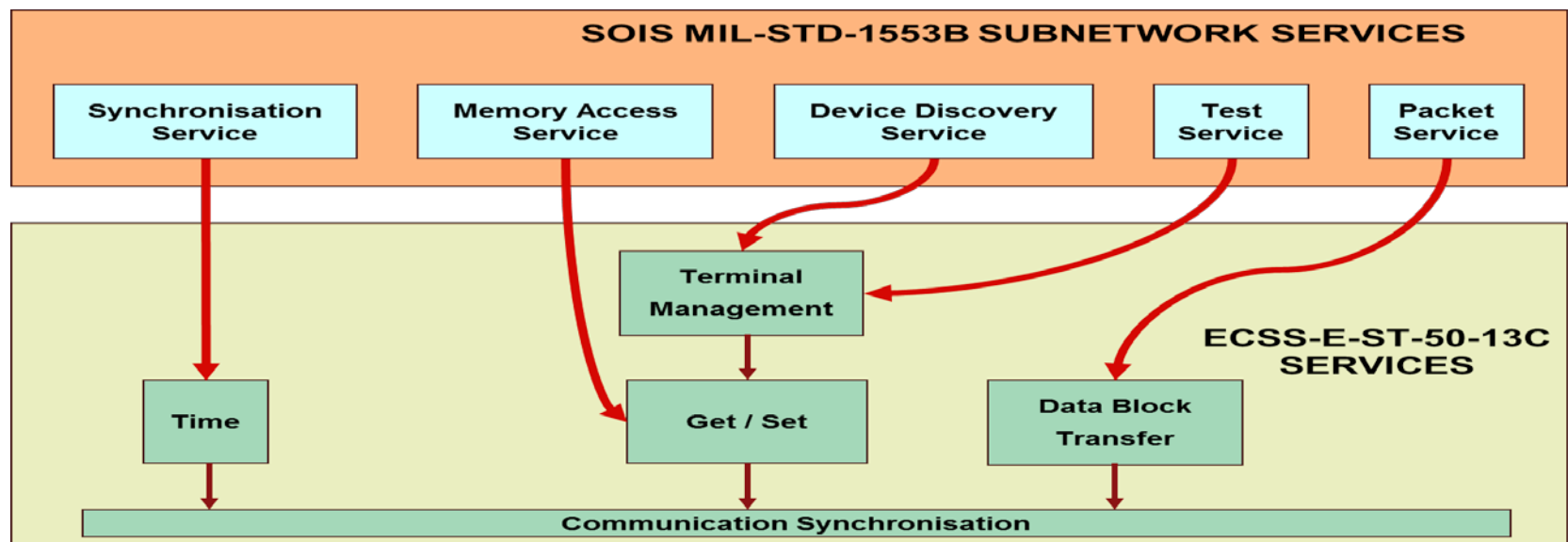
Mapping between SOIS subnetwork services and ECSS-E-50-13C is rather straight forward, but

→ **A conventional use of priority, channels and service classes in PS needs to be decided**

→ **Protocol for DDS is not defined**

Subnetwork Services - Spacewire

- MAS maps onto RMAP (ECSS-E-ST-50-52C)

- PS maps onto CPTP (ECSS-E-ST-50-53C)
  - → **but it's not a full featured packet transport protocol**

- SS should map onto CUC Time Synchronization/Distribution Protocol over Spacewire Networks
  - → **but it's in draft form and not well known outside the Spacewire community**

- DDS should map onto Spacewire Plug-N-Play Protocol
  - → **but it's in draft form and not well known outside the Spacewire community**

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SOIS service primitives/API

- SOIS service primitives are **not** API!
  - → **Many misunderstandings in the meaning of the parameters.**
    - Addressing across different subnetworks
    - Service Access Point
    - Transaction Identifier
    - Service Class
    - Service Metadata
    - Value Identifier

- Replacing the primitive "*indication*" with "*confirmation*" or "*response*" could help in the usage interpretation.

- No consensus on the need for standardising the API among Primes.
  - → **if done, API should support both synchronous and asynchronous SW architectures**

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Conclusions

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Conclusions 1/2

General considerations:

SOIS communication architecture
is useful as reference for

- the definition of communication protocols
- the definition of FSW basic/mission-independent services
- the definition of common terminology

Compliance to **SOIS standard is considered an enabler for the use of Electronic Data Sheet (EDS)** in the future

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Short term:

These recommendations will be feedback to the SOIS WG in the frame of the 5 years review of the subnetwork services and of the EDS standardisation

Mid term:

SOIS implementation by Primes is ongoing, an assessment of the recommendations is expected at the end of the 3 studies

Outputs:

Standard mapping between ECSS-E-ST-50-XX and recommended SOIS API could become defacto standards if all Primes will converge on a common solution