SAVOIR Communication Architecture

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Part 1

Summary

- Services for Prototype
- Lessons Learnt
- Prime's On-Board Communication Needs
- Current Execution Platform Architecture
- SOIS Positioning and Interoperability Needs
- Conclusion

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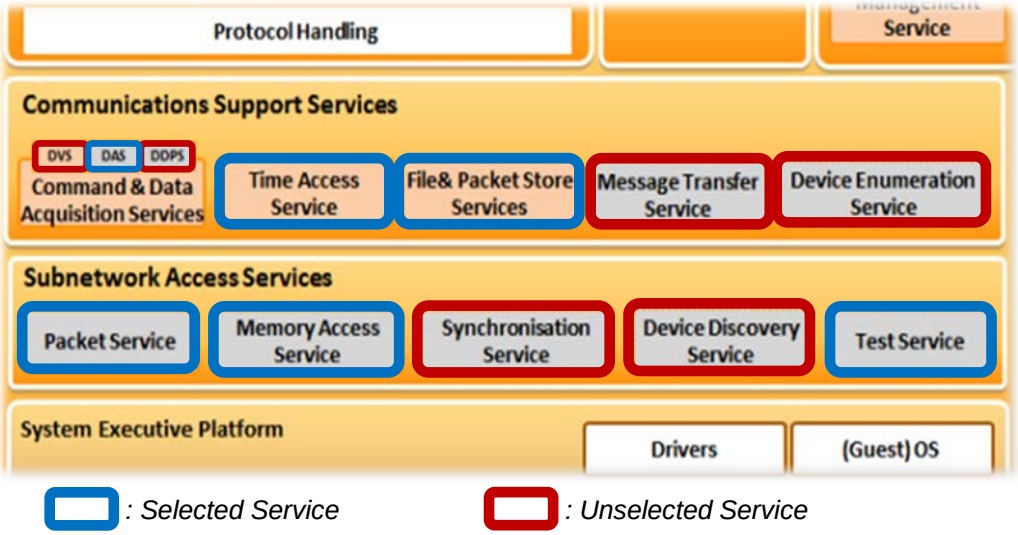
Services for Prototype 1/2

Activity Context

- **Objectives:**
  - Evaluation of SOIS standards
  - Integration of a subset of the services into an existing FSW architecture
- **A representative use case has been selected: Solar Orbiter FSW**
- **Services selection has essentially been driven by the development effort w.r.t. the potential added value and the non-applicability of some services**

Selected services for prototype

- **Device Access Service (DAS)**
- **Time Access Service (TAS)**
- **File and Packet Store Services (FPSS)**
- **Memory Access Service (MAS)**
- **Packet Service (PS)**
- **Test Service (TS)**



***Other SOIS feature*: EDS not considered in this study, but could be interesting for Primes**

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Services for Prototype 2/2

Unselected services for prototype

- **Device Virtualisation Service (DVS)**
  - Not applicable due to nominal/redundant equipment differentiation
  - Redundancy aspects not treated
- **Device Data Pooling Service (DDPS)**
  - Too dimensioned compared to the needs
  - Substantial development effort compared to the slight added value
- **Device Enumeration Service (DES) / Device Discovery Service (DDS)**
  - Effort to implement DDS too high (impacts on bus link traffic, feasibility on test bench)
  - Effort to implement “bottom-up” mechanisms too high (asynchronous indication mechanisms with messages, queues…) with respect to added value
  - Too low added value of “top-down” mechanisms
- **Message Transfer Service (MTS)**
  - Inter-application communication done via PUS services
  - MTS too dimensioned and high development effort
- **Synchronisation Service (SS)**
  - Not applicable to the selected use case

Lessons Learnt

An implementation of SOIS Services has been performed but

- **Substantial impact on the current FSW architecture**
- **Substantial effort to implement and test SOIS services**
- **No visible improvement**
  - Performance overhead introduced by SOIS layer
    - 1% increasing of CPU load
    - Increasing of the execution time for operation
      - 50% increasing for a STR TC transmission
      - 20% increasing for a SSMM TC transmission
      - 20% increasing for a test request/answer
      - 5% increasing for File operations
  - No SW architecture simplification
  - No SW memory budget reduction

Prime's On-Board Communication Needs

The main goal is interoperability

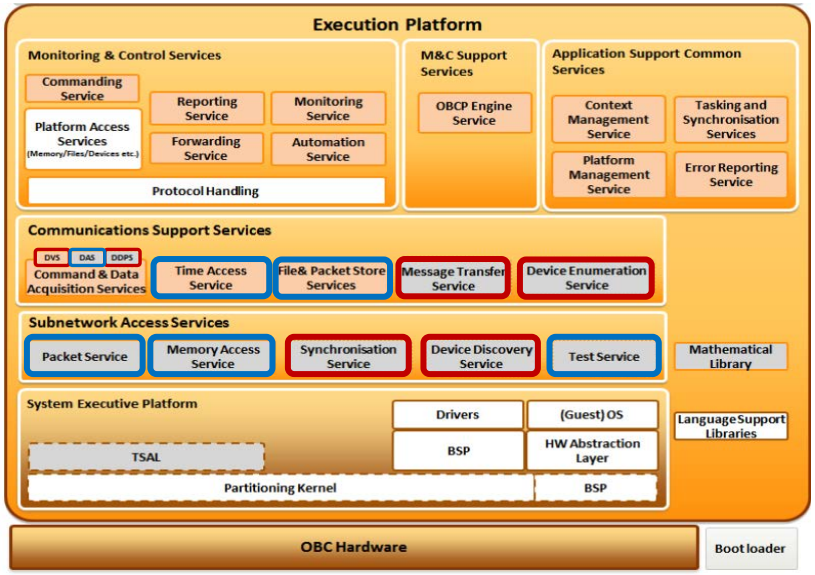
1. **Application development (above the Execution Platform) by various providers**
2. **SW adaptability to the variability of HW interfaces for smart sensors/actuators and payloads**
3. **SW adaptability to the variability of the On-Board Computer HW**
4. **SW adaptability to the variability of communication links**

Current Airbus Execution Platform Architecture

Our existing Execution Platform

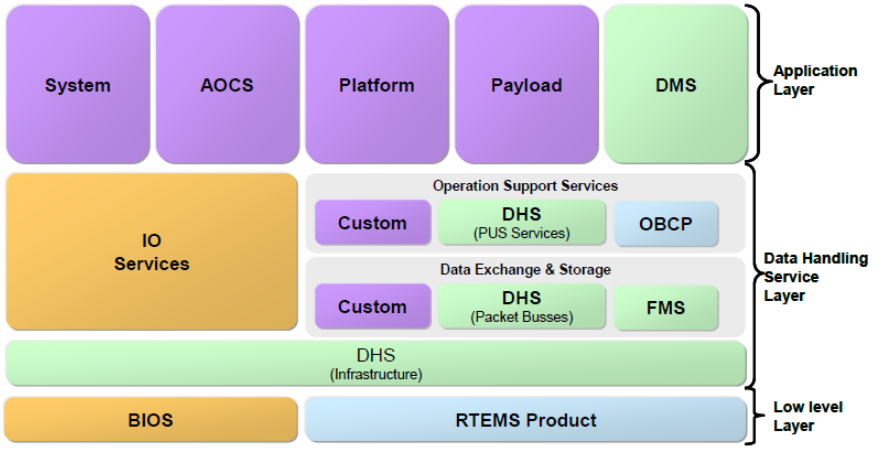
- **Application Support Layer: PUS Services**
  - Wide range of functionality
  - Reusable and customizable
  - But strongly integrated to the Exec PF

  ⇒ Key element of industrial efficiency



SAVOIR Execution Platform Architecture

- **Subnetwork Layer: similar mechanisms already used and satisfying in terms of**
  - Cost
  - Performance
  - Portability
  - Interoperability



Current Airbus Execution Platform Architecture

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SOIS Positioning and Interoperability Needs 1/2

1. **Application development: partially covered by SOIS**
   - The need is located at Execution Platform level
   - PUS Services already provide standardization elements
   - A lot of different applications from various missions can already be plugged on a single Execution Platform

   ⇒ *In the frame of MetOp SG, as precursor, Airbus Defence and Space made available interfaces of the Execution Platform (PIM SW), which is opening the applicative market*

2. **Sensors/Actuators and Payloads HW interfaces variability: not covered by SOIS**
   - The “Device Virtualization” and “Plug-and-Play” promoted in SOIS don’t fulfill this need
   - SOIS covers communications and access file functions aspect but doesn’t cover protocol and functional interfaces aspects

   ⇒ *It is needed to harmonize a standardized functionality core and interfaces, such as begun in the SAVOIR-SAFI initiative and could be supported/implemented through EDS*

SOIS Positioning and Interoperability Needs 2/2

3. On-Board Computer HW variability: partially covered by SOIS

- SOIS potentially covers communication functions access
- But other parts are missing such as configuration data and I/O controller aspects

4. Communication links variability: covered by SOIS and the study

- SOIS relies on a unique and simple model based on
  - messages
  - memory accesses
  - packets
- But no standardized mapping between SOIS and ECSS communication standards

⇒ *If a new bus is used or if an equipment on a specific link is changed for one on another link, adaptations have to be performed thus SOIS doesn't provide any added value*

⇒ *Airbus Defence and Space (and other Primes) use standardized avionic architectures and Execution Platforms already integrate adaptations w.r.t. the type of links (1553, SpW, CAN, UART)*

Conclusion

Our current Execution Platform is already efficiently covering interoperability needs despite important variability factors (Applications development, OBC, Communication Bus, Equipment).

The study has shown that implementing and integrating SOIS Services in our existing Execution Platform would require a very significant effort with limited added value on avionics interoperability needs.

The integration of SOIS layers in future OBSW can only be considered with next generation of avionics architecture including:

- **On-Board Computer with more powerful CPU & Intelligent I/O controller**
- **New generation of data communication network**
- **Functional interfaces standardization of all equipment of the avionic platform & payload interfaces**

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Thank you for your attention !

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Part 2

Summary

- Recommendations regarding Interoperability Needs
- Roadmap

Recommendations regarding Interoperability Needs 1/2

The main goal is interoperability

1. **Application development (above the Execution Platform) by various providers**

   ⇒ Execution Platform holders should make available their interfaces/user manuals

2. **SW adaptability to the variability of HW interfaces for smart sensors/actuators and payloads**

   - Protocol aspects to be deepened, necessitate a low effort

   ⇒ SAVOIR-SAFI initiative should be restarted and extended to treat sensors/actuators and payload functional aspects and could be supported through EDS

   ⇒ Payload interfaces standardization could also be treated as a supplementation of the hosted payloads standardization

   ⇒ It could be extended to semi-functional sensors/actuators such as RIU and PCDU. In this frame, the priority should be the SAVOIR RTU Operability Requirements document completion

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Recommendations regarding Interoperability Needs 2/2

The main goal is interoperability

4. SW adaptability to the variability of the On-Board Computer HW

- SOIS shouldn't be considered as a standardization solution of Low-Level SW interfaces for On-Board Computer HW providers
- As shown by the prototyping activity, it is not a good solution to guarantee satisfying performances

⇒ This variability should be treated in the SAVOIR generic OBC specification

⇒ Anyway, on current on-board computer, this point is mainly an industrial efficiency matter for our Execution Platform

5. SW adaptability to the variability of communication links

⇒ As for the On-Board Computer HW variability, on current set of communication links, this is mainly an industrial efficiency matter for our Execution Platform

Roadmap

As Prime, since conditions are not met to deploy SOIS Services (i.e. no technological break), it is preferable to streamline the current need and thus deeper investigate

- **Intelligent I/O Controller**
- **On-Board Computer with more powerful CPU**
- **Next generation of Communication Network**
  - More bandwidth, Network Management, Quality of Service, etc.
- **Standardization of external communication interface and protocol with equipments up to the functional level**
  - SAVOIR-SAFI initiative restarting
  - SAVOIR RTU Operability Requirements document completion

Outcomes from all initiatives will potentially be merged in an Execution Platform New Generation, which will go hand in hand with the redefinition of the standard avionic architecture and the adoption of a communication network next generation.

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