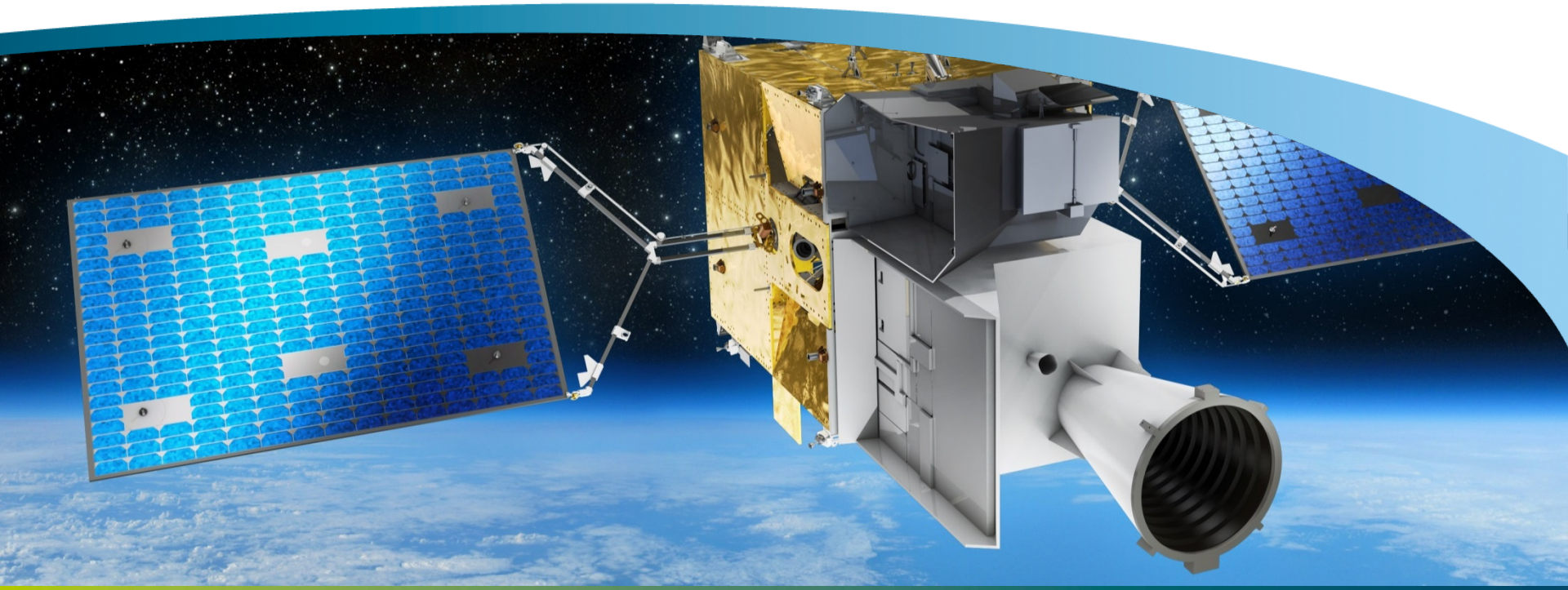
OHB System AG
Christian Westendorf
08/12/2015, ESA-ESTEC



SPACE SYSTEMS

SAVOIR Communications Architecture – OHB Final Presentation

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Agenda

- Background, Purpose and Objectives
- Tasks and Milestones
- FSW V1.0 versus FSW V2.0
- Roadmap for a Fully SOIS and ECSS Compliant FSW V2.0
- Lessons Learned and Conclusions
- Future use of SOIS Services at OHB

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Background, Purpose and Objectives

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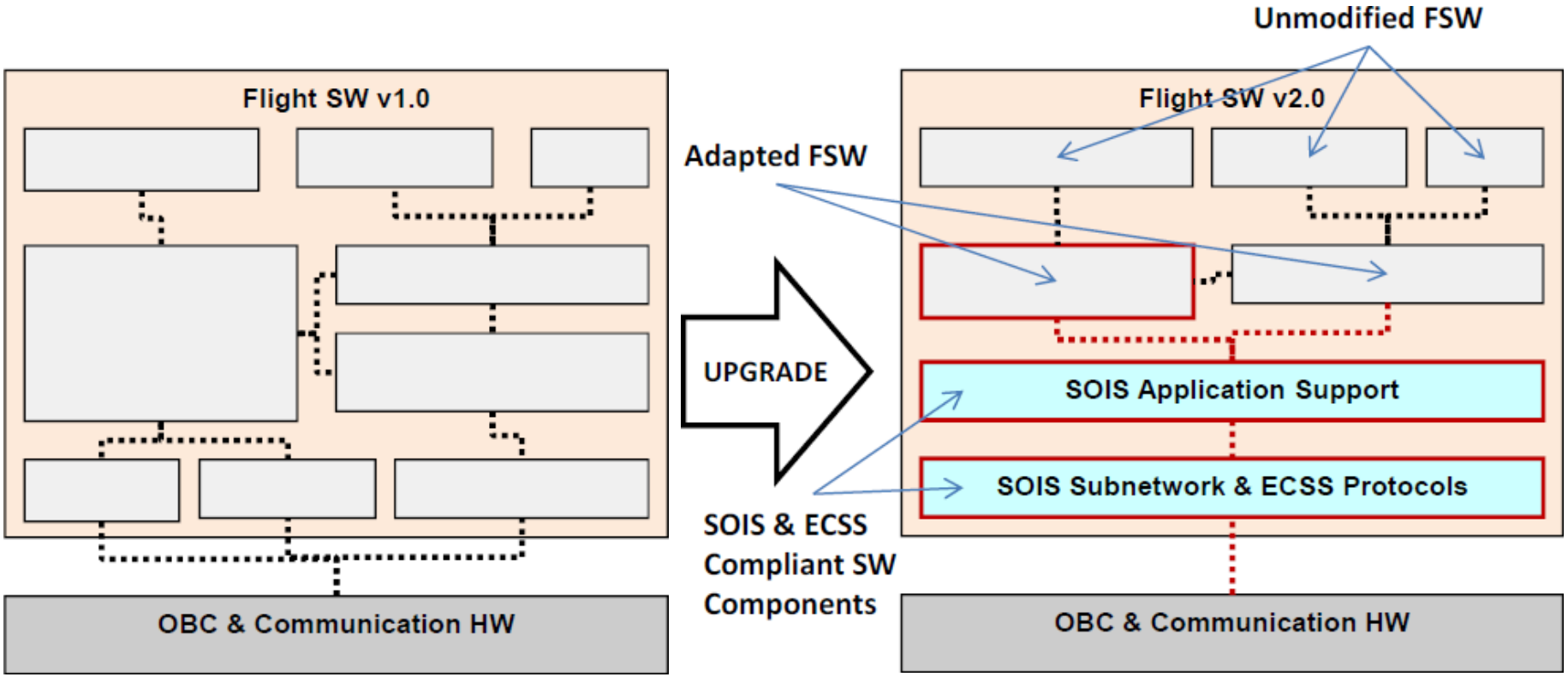
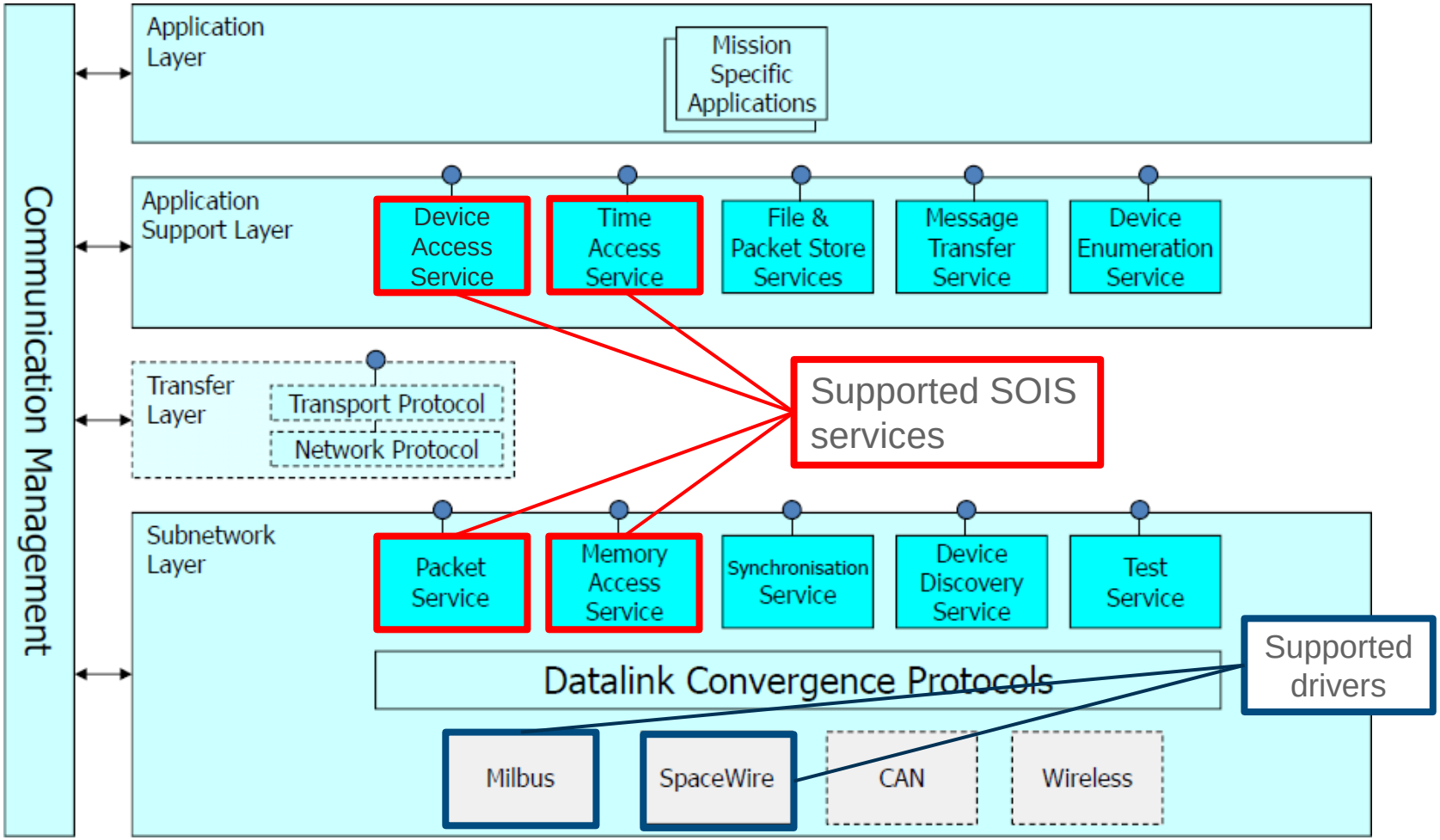
Purpose and Objectives

- **Critical review** of the applicable SOIS and ECSS standards.
- **Selection** of the flight SW to be modified (FSW V1.0).
- Define the **architecture** of the upgraded flight SW (FSW V2.0).
- **Design and develop** the specified SOIS and ECSS compliant SW.
- **Validate and verify** the performance of the upgraded flight SW on a SVF.
- Define the **roadmap** for an operational flight SW that is fully compliant to the applicable SOIS and ECSS standards.

Transition from FSW V1.0 to FSW V2.0



SOIS Communication Architecture



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Tasks and Milestones

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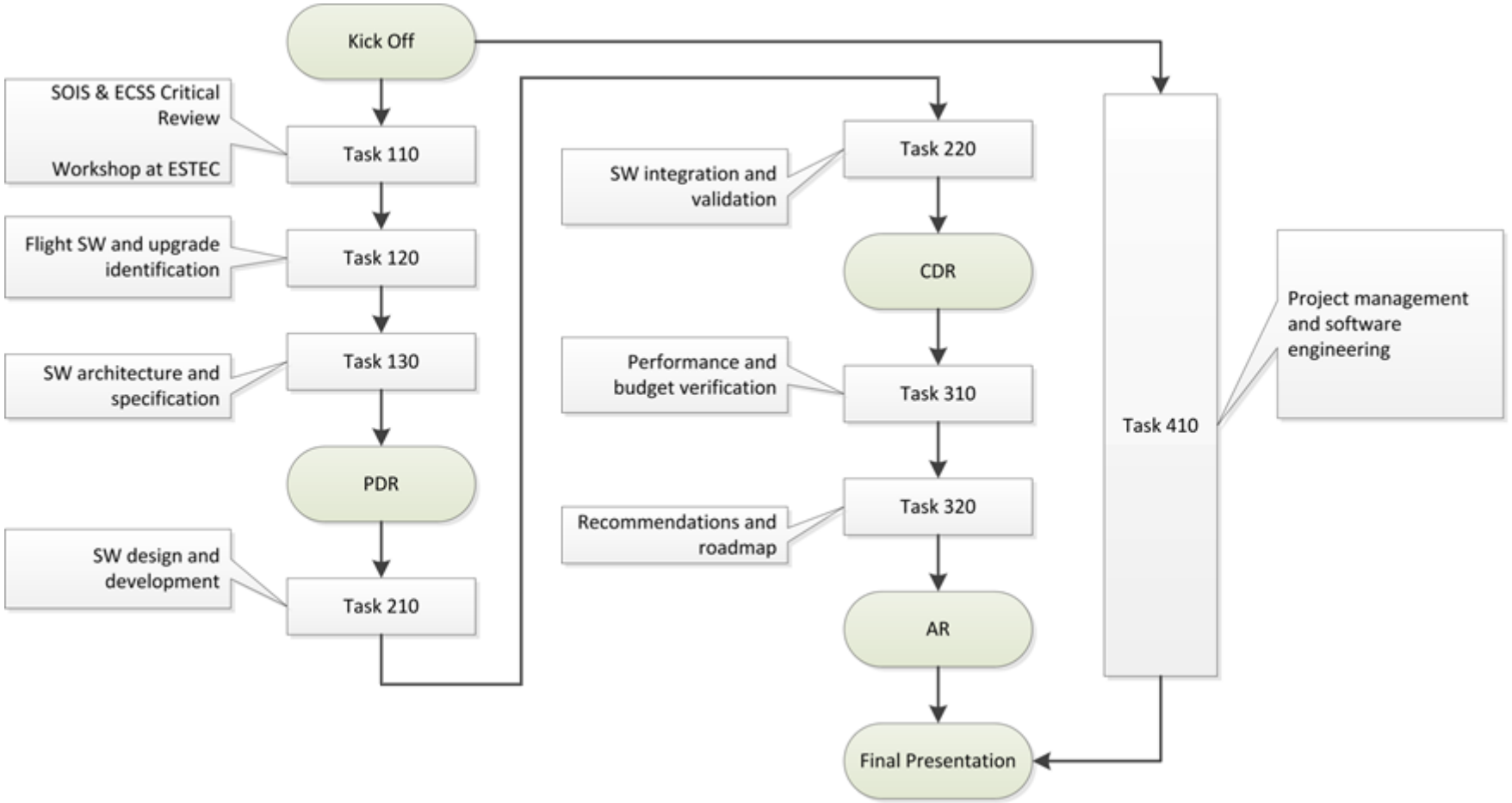
Task Overview and Workflow



Milestones Overview

Milestone	Task(s)	Achievements	Timeline
PDR	110, 120, 130 and 410	• Critical SOIS & ECSS Review. • Workshop at ESA-ESTEC. • Identification of the FSW V1.0 • Selection of FSW V1.0 upgrades. • SW requirements specification. • SW architecture document.	T0 + 5 Month
CDR	210, 220 and 410	• SW design document. • FSW V2.0 • Unit- and validation tests.	T0 + 13 Month
AR	310, 320 and 410	• Performance and budget verification. • Recommendations and roadmap.	T0 + 15 Month
FP	410	• Final Presentation.	T0 + 18 Month

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FSW V1.0 versus FSW V2.0

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How to Compare the FSWs

- All tests on the same simulator.
- Same compiler and the same compiler flags.
- Compare the FSWs via:
  - Memory budget comparison.
  - Performance tests in different scenarios.
  - Performance tests SOIS service (FSW V2.0) <-> FSW V1.0 feature.

Hardware

- ERC32 CPU with 20 MHz (14 MIPS at 32 Bit processor word size).
- 6 MiB RAM plus 2 MiB communication RAM.
- 3 MiB EEPROM (split into two banks with 1.5 MiB).
- 512 KiB SGM RAM.
- 256 KiB SGM EEPROM.

Memory Budget Comparison

Memory	FSW V1.0	FSW V2.0	Alteration
Binary Size	1040 KiB	1141 KiB	**+6.8%**
Text Section (PM EEPROM)	782 KiB	890 KiB	**+7.2%**
User Data (PM RAM)	1573 KiB	1586 KiB	**+0.8%**
Runtime Allocation (PM RAM)	2613 KiB	2727 KiB	**+1.9%**
Communication RAM	1397 KiB	1397 KiB	0%
SGM RAM	253 KiB	253 KiB	0%
SGM EEPROM	39 KiB	39 KiB	0%
PM EEPROM total	69.3%	76.1%	**+6.8%**
PM RAM total	69.8%	71.8%	**+2%**

SW Service Memory Usage

FSW Module	FSW V1.0 [KiB]	FSW V2.0 [KiB]	Alteration (FSW V1.0 to FSW V2.0) [KiB]
Time Access Service	-	0.5	-0.5
On Board Time Service	12	11	
Packet Service	-	6.7	+8.5
Memory Access Service	-	17.2	
MilBus Driver	34	31.5	
SpaceWire Driver	19	6.1	
Device Access Service	-	11.4	-3.6
Data Management Service	15	-	

FSW Performance Comparison (Part 1/2) – Overall FSW Performance

Scenario	CPU Load FSW V1.0	CPU Load FSW V2.0	Scenario Description
Start-Up	38%	**39%**	Early start-up phase plus unit activations / initial operational activities.
Basic	24%	24%	Subsystems are in basic mode, Payload is OFF and AOCS is in SAM.
Nominal	26%	**27%**	Subsystems are in basic mode, Payload is ON, basic monitoring is ON and AOCS is in EAM.
Stress	36%	**37%**	Subsystems are in basic mode, Payload is ON, AOCS EAM and all monitorings are switched ON (stress).

FSW Performance Comparison (Part 2/2) – SOIS Service Performance Tests

Test	Tested Service	CPU Load FSW V1.0 [%]	CPU Load FSW V2.0 [%]	CPU Load Difference [%]
1000x SpaceWire Read	MAS	23.964	24.942	**+0.978**
1000x SpaceWire Write	MAS	23.286	23.964	**+0.678**
1000x Data Pool Read (500x MilBus & 500x Virtual Data)	DAS	1.9575	2.445	**+0.4875**
1000x Data Pool Write (500x MilBus & 500x Virtual Data)	DAS	1.467	2.445	**+0.978**
1000x Get Time	TAS	1.4685	2.4465	**+0.978**
100x DBTP Read	PS	6.3570	6.6275	**+0.2705**
100x DBTP Write	PS	7.8255	8.3145	**+0.489**

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Fully SOIS and ECSS Criticality Level-B Compliant FSW V2.0 Roadmap

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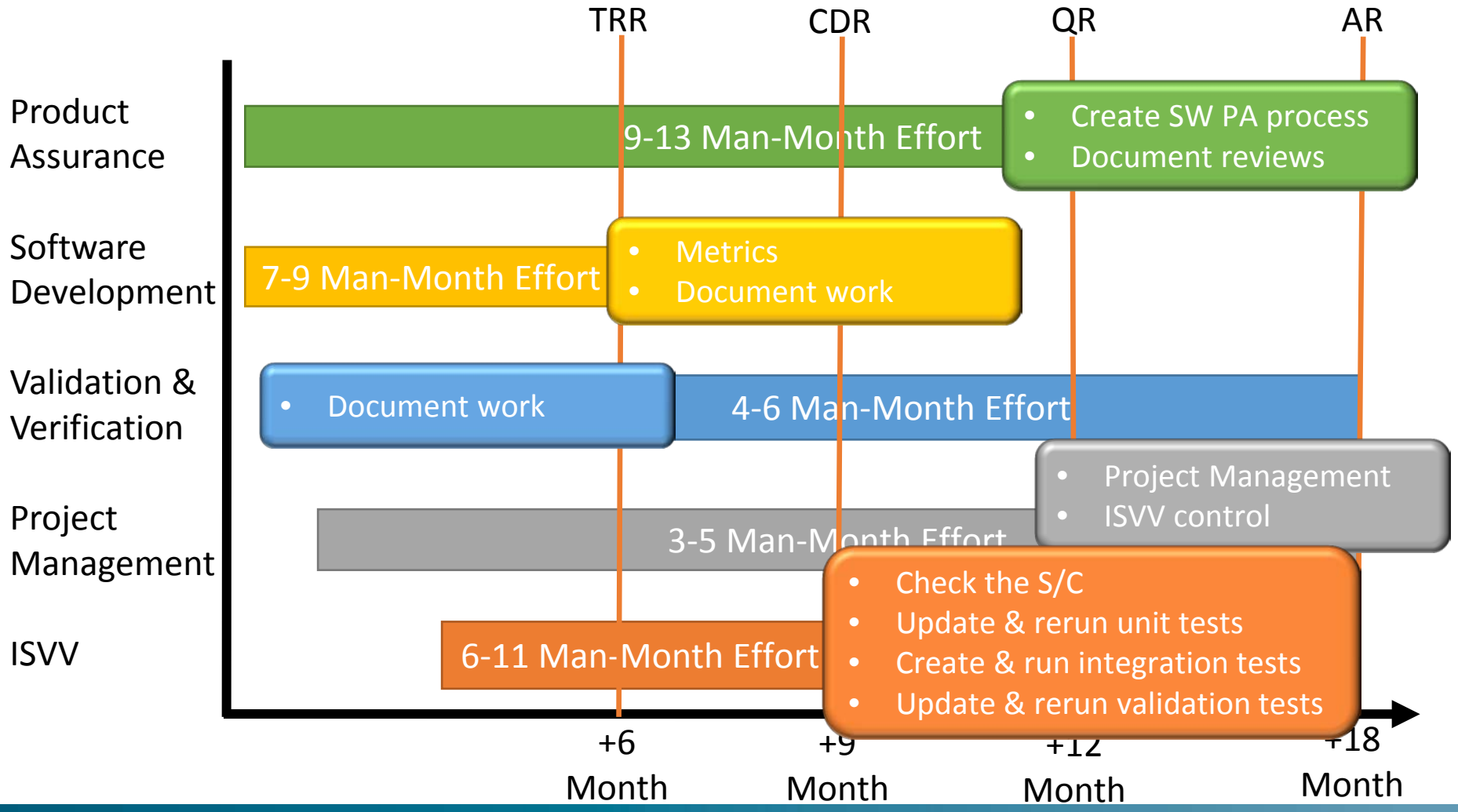
Requirements

- Fully ECSS-E-ST-40 & ECSS-Q-ST-80 criticality level-B compliant.
  - Including ISVV
- Base on the ECSS tailored FSW V2.0.
- 4 Roles:
  - Software Project Manager.
  - Software Product Assurance Manager.
  - Software Developer.
  - Software Validation and Verification Engineer.

Timeline (Fully SOIS & ECSS Compliant FSW V2.0)



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Lessons Learned and Recommendations

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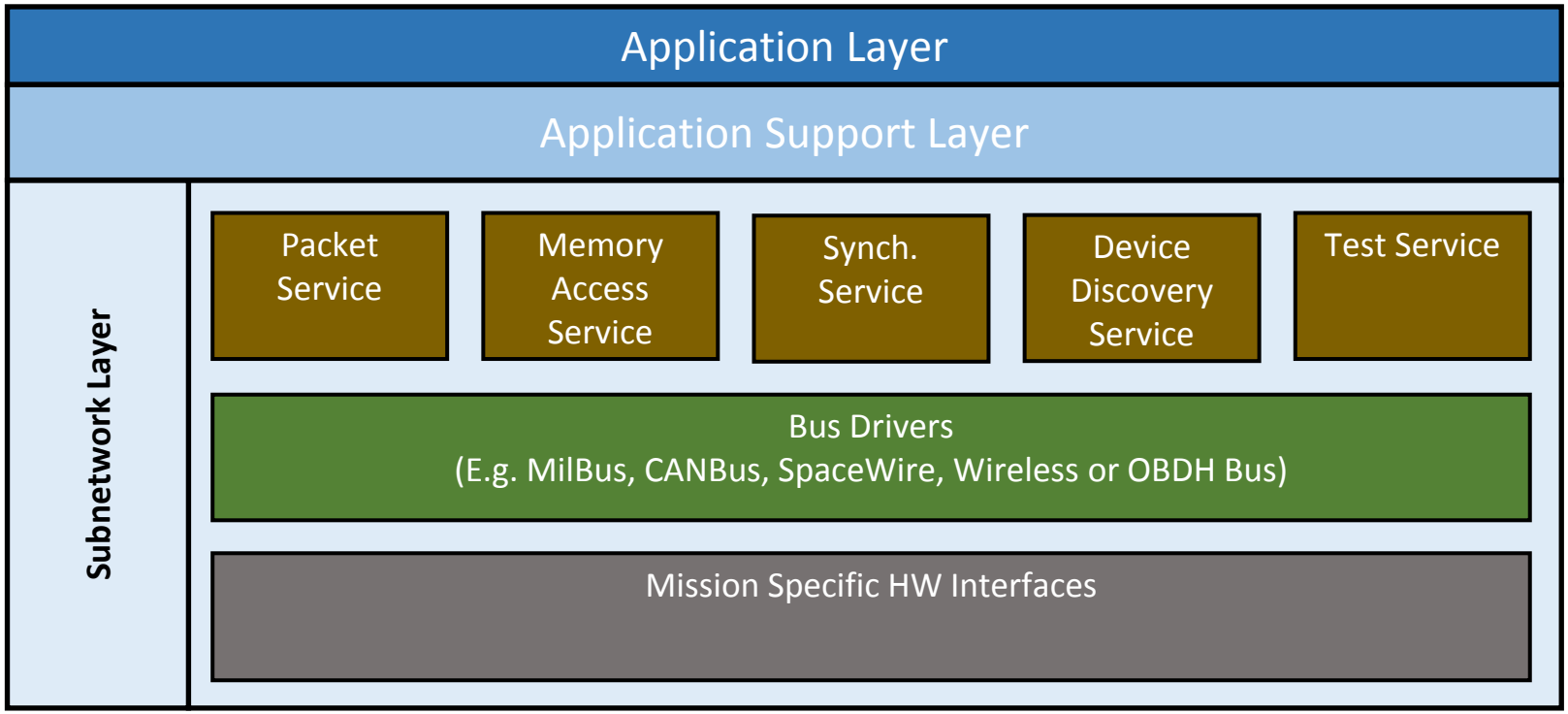
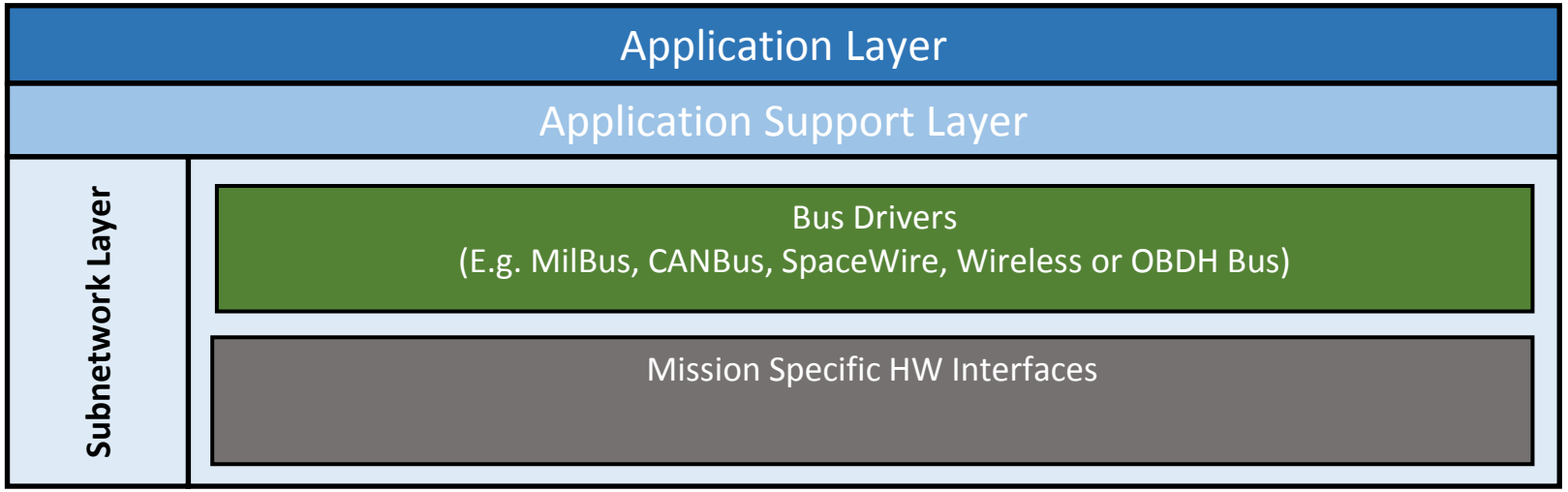
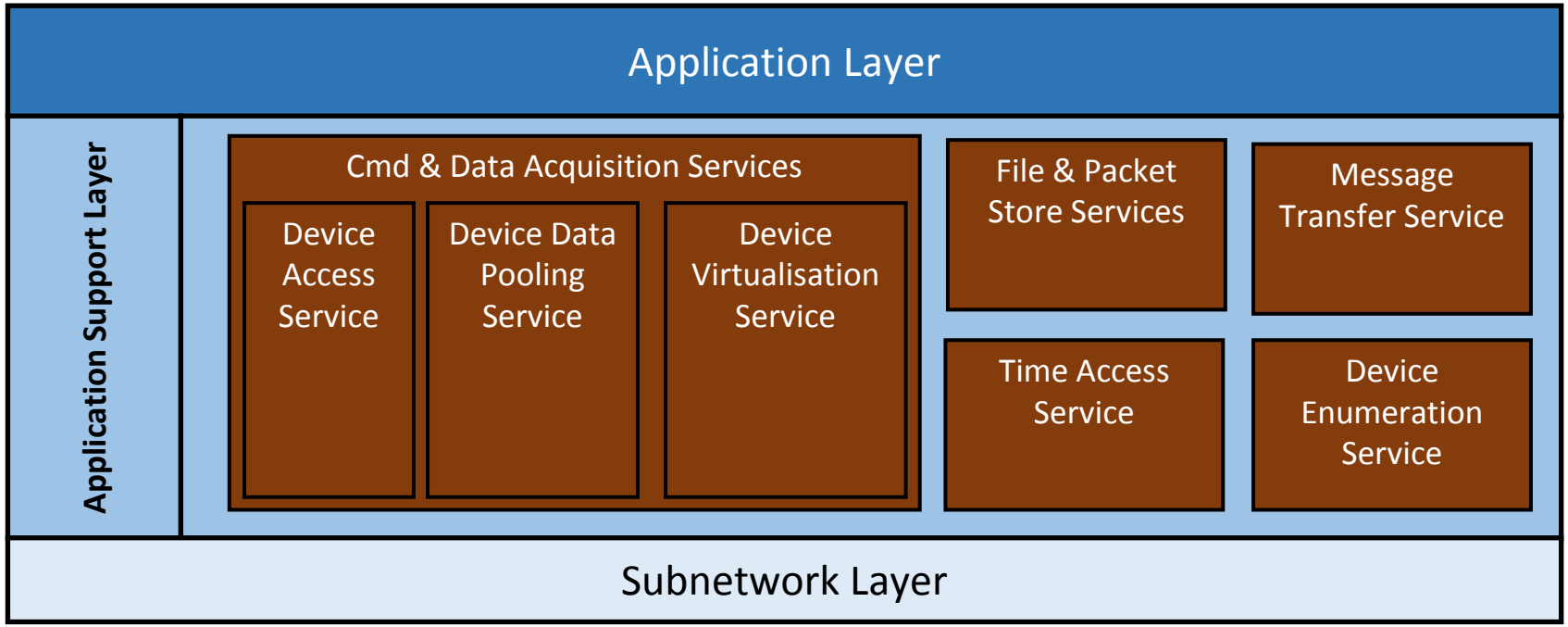
SOIS Architecture – Subnetwork Layer



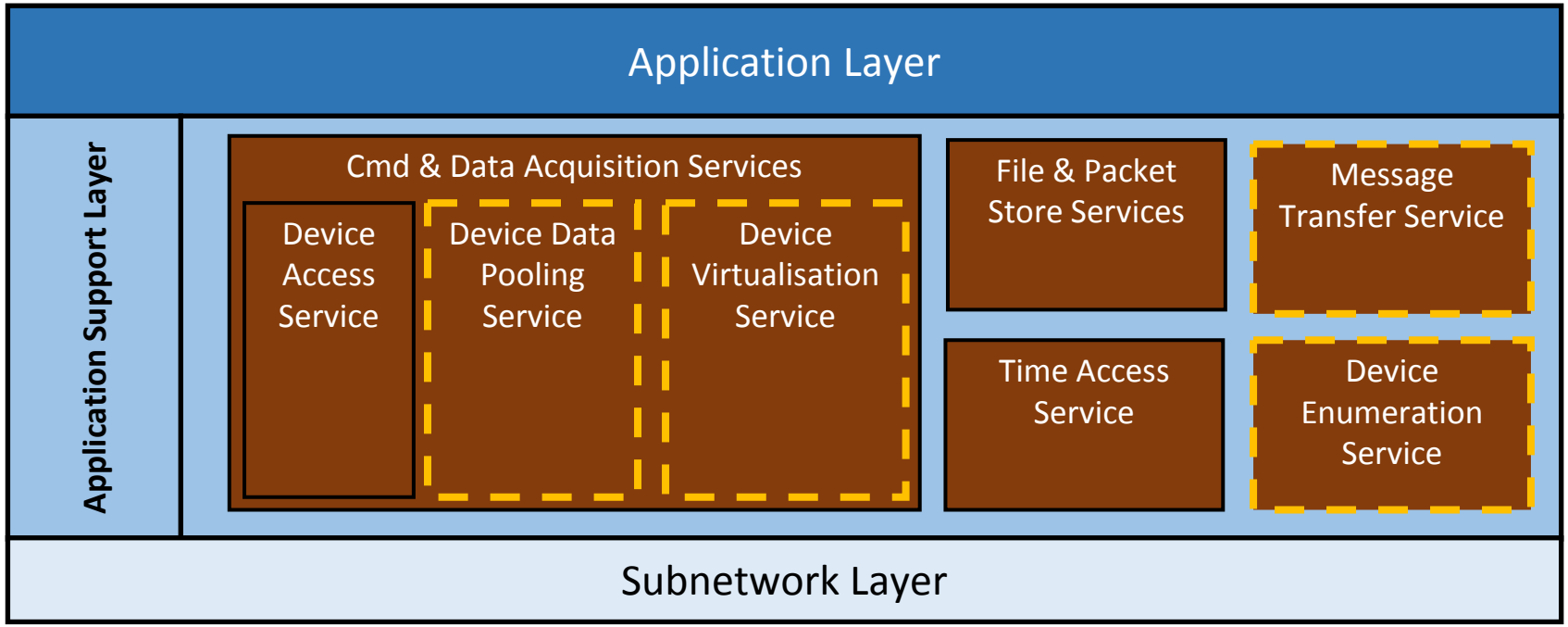
Recommended SOIS Architecture – Subnetwork Layer



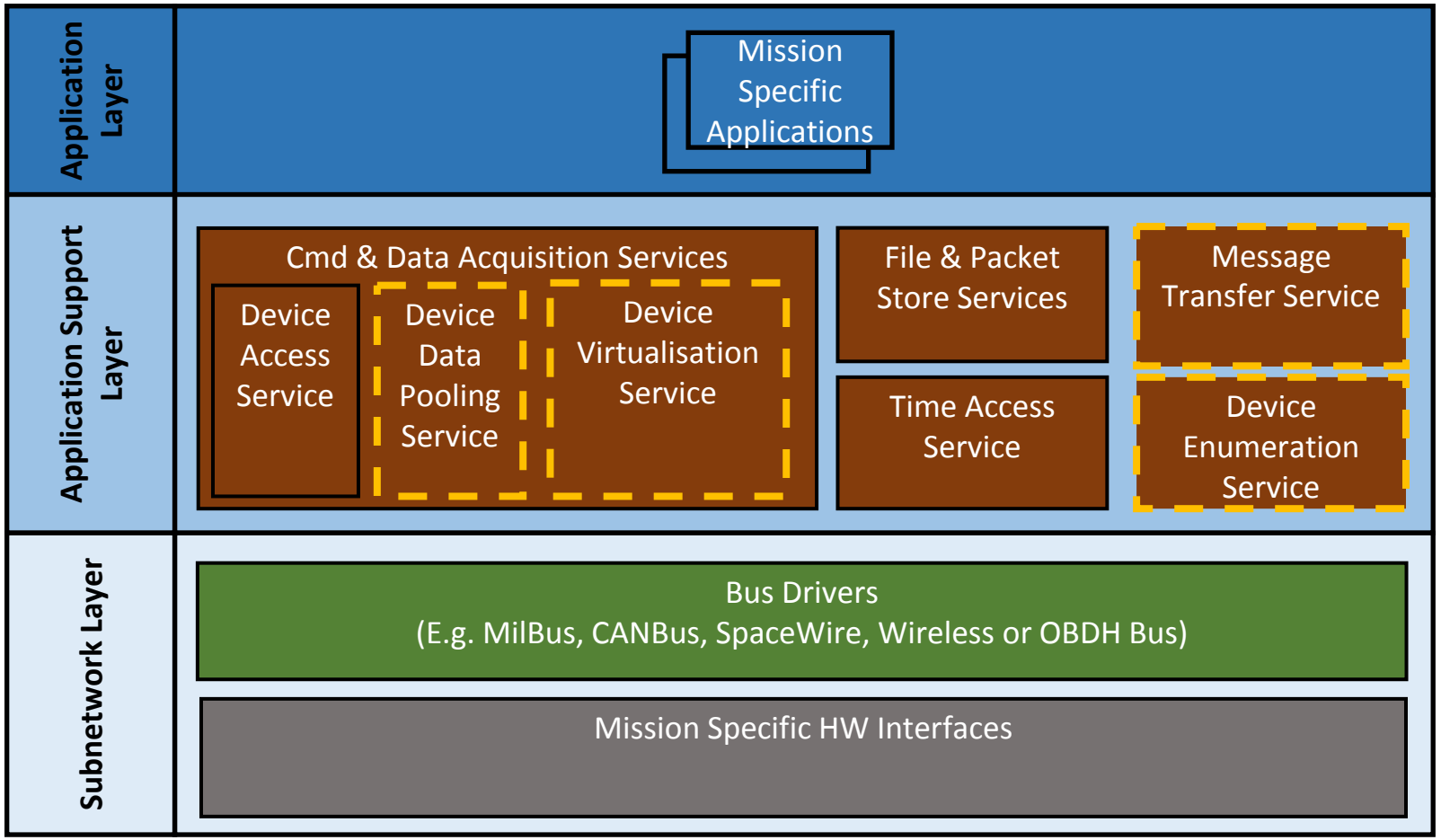
SOIS Architecture – Application Support Layer



Recommended SOIS Architecture – Application Support Layer



Recommended SOIS Architecture



Summery: SOIS Services

- The SOIS services that are planned to be used at OHB in the future are:
  - Time Access Service.
  - Packet Store Service.
  - Device Access Service.
- All other SOIS services are not considered to be used in future by OHB.
  - Subnetwork layer services are part of the bus drivers.
  - No current use cases for the other application support layer services.

Summery: SOIS Layers

- In general, the three SOIS layers architecture is good concept.
- The subnetwork layer should not to be used at it is defined in the SOIS standard at the moment. -> Make is at least optional.

Summery: Project Issues

- To adapt an existing architecture (FSW V1.0) leads to less efficient solutions and to non meaningful performance statements.
- The FSW V2.0 is slower wrt. the performance and has a bigger size.
- It is recommended to use the SOIS concept in a new developed flight software, where the concepts can be developed from scratch without any legacy issues.

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Future use of SOIS Services at OHB

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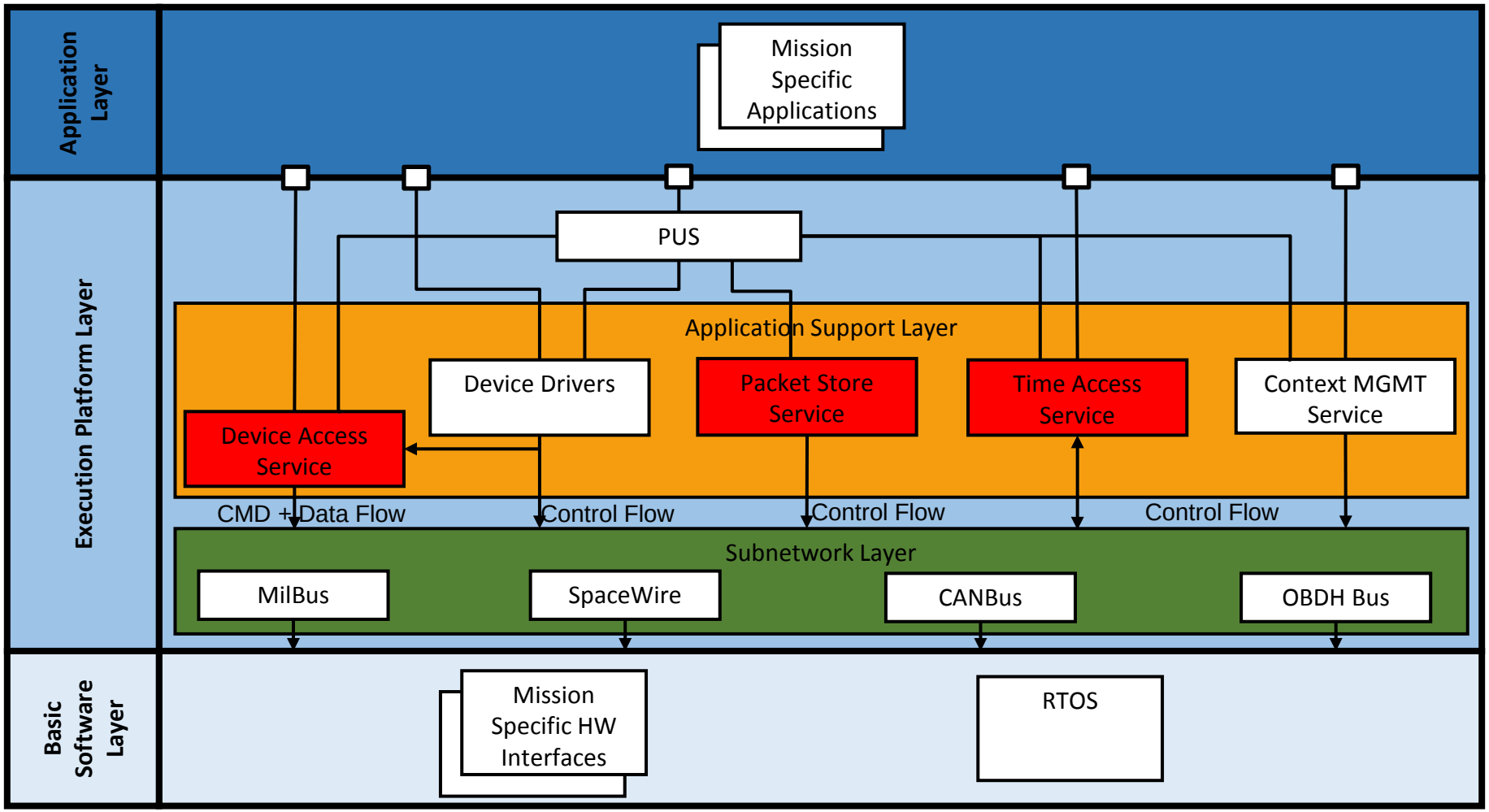
Possible Future OHB Architecture



Thank you for your attention!

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