

## **Introduction to SAVOIR**

On behalf of the SAVOIR Advisory Group Kjeld Hjortnaes – ESTEC/TEC-SW Head of Software Systems Division



## SAVOIR.

**SAVOIR** means *Space Avionics Open Interface aRchitecture*. *An initiative to federate the European Space Avionics Community and together improve the way we build Spacecraft avionics.* 

#### **SAVOIR** objectives:

- Improve the way we deliver space systems
- Support industrial competitiveness
- Enhance product orientation

**SAVOIR** is coordinated by the Savoir Advisory Group (SAG) including representative of;

- Agencies: ESA, CNES, DLR
- Large Satellite Integrators: Airbus-DS, Thales Alenia Space, OHB
- Avionics HW and SW suppliers: RUAG, Selex Galileo, Terma













Together ahead. RUAG

TERMA<sup>®</sup>







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





# **SAVOIR Output**

The primary outputs of Savoir are:

- reference avionics architecture for spacecraft platform hardware and software,
- the definition of building blocks composing the architecture,
- a set of avionics external and internal interface specifications,
- the functional specification of selected building blocks comprising the architecture,
- Demonstrate maturity of the functional & Interface specification by performing prototyping activities
- Facilitating the implementation of selected building blocks.







# **SAVOIR** perimeter



- SAVOIR focus on the Platform Avionics including Payload Interfacing
- Build on the pillars
  - Data Handling Hardware
  - Control Sensors & Actuators
  - On-board Communication
  - Flight Software
  - The operations view
- Related topics
  - Development and Verification Process.
    - Model Based Development
    - Functional Verification strategy.
    - Links the system data repository.



## **SAVOIR** perimeter





## Savoir output











## **Relation to Standards**



Арр	licable ECSS standards
_	E-50 branch
	ECSS-E-ST-50-01C Space data links -
	Telemetry synchronization and
	channel coding 31 July 2008
	ECSS-E-ST-50-03C Space data links -
	Telemetry transfer frame protocol
	31 July 2008
	ECSS-E-ST-50-04C Space data links -
	Telecommand protocols,
	synchronization and channel coding
	31 July 2008
	ECSS-E-ST-50-12C SpaceWire -
	Links, nodes, routers and networks
	31 July 2008
	ECSS-E-ST-50-13C Interface and
	communication protocol for MIL-
	STD-1553B data bus onboard
	spacecraft 15 November 2008
	ECSS-E-ST-50-14C Spacecraft
	discrete interfaces 31 July 2008
	ECSS-E-ST-50-51C SpaceWire
	protocol identification 5 February
	2010
	ECSS-E-ST-50-52C SpaceWire -
	Remote memory access protocol 5
	February 2010
	ECSS-E-ST-50-53C SpaceWire -
	CCSDS packet transfer protocol 5
	February 2010

#### E-60 branch

ECSS-E-ST-60-30C Attitude and Orbit Control System (AOCS) requirements

ECSS-E-ST-60-20C Startracker

#### E-70 branch

ECSS-E-ST-70-01C OBCP

ECSS-E-ST-70-11C Operability

ECSS-E-ST-70-41C Telemetry and Telecommand Packet Utilisation

Applicable	e CCSDS standards
	CCSDS 133.0-B-1 Space Packet Protocol September 2003
(	CSSDS 850.0-G-1 Spacecraft Onboard Interface Services June 2007
	CCSDS 851.0-M-1 Spacecraft Onboard Interface Services - Subnetwork Packet Service December 2009
( 5 [	CCSDS 852.0-M-1 Spacecraft Onboard Interface Services - Subnetwork Memory Access Service December 2009
( 5 [	CCSDS 853.0-M-1 Spacecraft Onboard Interface Services - Subnetwork Synchronisation Service December 2009
	CCSDS 854.0-M-1 Spacecraft Onboard Interface Services - Subnetwork Device Discovery Service December 2009
	CCSDS 855.0-M-1 Spacecraft Onboard Interface Services - Subnetwork Test Service December 2009
C F E	CCSDS 355.0-R-2 Space Data Link Security Protocol (Draft Recommended Standard, Red Book) February 2012
	- CCSDS File Delivery Protocol [CFDP]



## **The Avionics Reference Architecture**





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## **The Avionics Reference Architecture**





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#### **SAVOIR HW Reference Architecture Functional View**.





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## **Communication Network & Protocols**







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#### **Software Reference Architecture**





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## **Software Reference Architecture Execution platform – 'Classic'**







#### **Software Reference Architecture Execution Platform – 'Time & Space Partitioning'**





## **SAVOIR output examples**





# **Specification production scheme.**



Under SAG agreement;

- 1. A draft version is produced;
  - By a SAG working group
  - Output of an R&D activity
  - Proposed by Industry
  - ESA internal
- 2. Submitted for **restricted review** and updated as needed
  - Check compliance to SAVOIR architecture and principle
  - Completeness / consistency / etc
- Submitted for public review and updated (same objective as 2) ECSS/Eurospace
- Verified by prototyping to demonstrate maturity of the spec., consistency with the ref architecture (as far as possible on a case by case basis)

5. Publication





## **Dissemination of SAVOIR output**



#### http://savoir.estec.esa.int/



Space AVionics Open aRchitecture is an initiative to federate the space avionics community and to work together in order to improve the way that the European Space community builds avionics sub-systems.

#### What are the objectives?

- To reduce the schedule and risk and thus cost of the avionics procurement and development, while preparing fo the future
- To improve competitiveness of avionics suppliers
- Annual workshop Workshop on Avionics, Data, Control and Software Systems



#### **Overview of the workplan**





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## **Architecture and system**



	Saman an Anakita atuma
Savoir Rei	rerence Architecture
	Savoir functional reference architecture
Contribut	ion to generic <u>System Requirement Document</u> (ESA
document	t)
	Avionics contribution per discipline
Savoir Wh	nite Papers
	- Savoir systems use recommendation: Production of a "how to use" recommendation as a "white paper", (concept and recommendations). Equivalent to a "green book" in CCSDS or a "Handbook " in ECSS.
	- Savoir systems implementation recommendation: Production of a "how to implement" recommendation. OBC, RTU and Platform/Payload
	<ul> <li>Savoir systems implementation recommendation: Control, Sensor, Actuator side</li> </ul>
	- Cross strapping of Sensor Actuators w.r.t. RTU
FDIR	
	- FDIR process
Mass Mer	nory [SSMM]
Step-1	- System/Operational requirement – SAVOIR-Masais
Step-2	Functional & Interface Spec (OBC/SSMM and Payload/SSMM)
Platform/	payload interfaces
	- Interface Specification
	- Concept of hosted payloads (using Time and Space Partitioning)
Security	
	- Impact of security on the reference architecture
	- Space data Link Security Protocol CCSDS

# SAVOIR Functional Reference Architecture SAVOIR/12-001/JLT





SAVOIR general recommendations for Platform Payload interface - draft



#### Hardware













SAVOIR General Recommendations for Spacecraft Monitoring and Control SAVOIR/12-006/MM Under development

Space ground interface			
	- Generic Operation Interface requirement Document [OIRD]		
	- Operability Change Requests to ECSS-E-70-11		
	- File Based Operations [FBO] concept		
	<ul> <li>Packet Utilisation Standard [PUS] services</li> <li>ECSS-E-ST-70-41C</li> </ul>		
On-Boa	rd Control Procedure [OBCP]		
	- ECSS-E-ST-70-01 update		



The revised PUS standard is in public review





## Communication

-	

Communication bus protocols						
	- Time Trigerred Protocol [TTP]					
	- RS422 protocol (interface specification into a standard)					
	- RS422 protocol standard					
	- CFDP protocol (CCSDS)					
Space C	Open Interface Specification [SOIS]					
	- Electronic Data Sheet					
	<ul> <li>Application Support Layer:</li> <li>CMD &amp; Data Acquisition service [DVS, DAS, Dev</li> <li>Data Pool]; Device Enumeration service</li> </ul>					
	<ul> <li>CCSDS SOIS Sub-network layer Spacewire (update)</li> </ul>					
	Network management and FDIR for SpaceWire networks					
	- CCSDS SOIS Sub-network layer CAN					







#### Control



<u>Control</u>	sensor/actuator interface - Functional interfaces specification - Startracker [STR]		SAVOIR-SAF	OPERA-	SOFTWAR	
	<ul> <li>ECSS-E-60-20C complement with STR I/F</li> <li>Functional interfaces specification - Gyro (ECSS-WG)</li> </ul>			CONTROL	ARCHI- TECTURE & SYSTEM	PROCESS
	<ul> <li>Functional interfaces specification - GNSS</li> <li>Receiver</li> </ul>				COMMUNI-	HARDWARE
	<ul> <li>Functional interfaces specification - Reaction</li> <li>Wheels (SAFI)</li> </ul>				CATION	
	- Electrical interface [SAIF]	s	AVOIR-SAIF			
Contro	sensor/actuator					Done
	Unit simulation models					
AOCS				CON-		Un-going
	Reference specification of AOCS ECSS-E-ST-60-30C					About



#### Software



Flight Computer Initialisation Sequence SAVOIR/12-007/FT Under review Initialisation software - Initialisation software specification SOFTWARE OPERA-BILITY Software reference architecture PROCESS ARCHI-TECTURE - Component model - Execution platform and application interface 8 CONTROL SYSTEM HARDWARE - Training material on the reference architecture COMMUNI-CATION SIFSUP Software factory individual activities supported under R&D programme







#### Process, etc











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#### Contact



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