



Savoir Safi status

Sensor Actuators

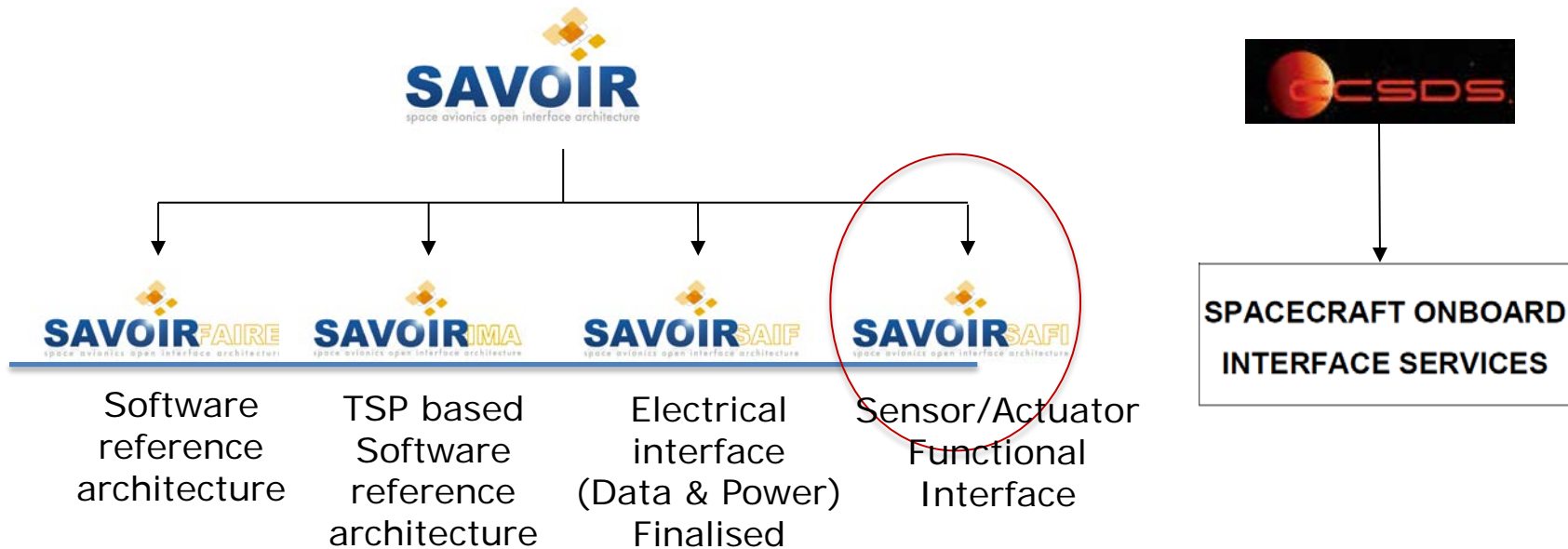
Functional Interfaces

Industrial support activity (STR)

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SAFI - Context



- Sensor and Actuators play a major role in the avionics
- **SAIF**, Electrical interfaces (incl. power): identified one new requirement, the need to standardize the RS422 protocol
- **SAFI**, Functional interfaces: from the software control loop to the equipment at functional level



SAFI Phase 1 - Scope



- SAVOIR SAFI focus is to investigate existing sensors and actuators from the **functional interface** standpoint in order to identify commonality for future standardised I/F, and extend it for the future.
 - Share the knowledge: Bring together the Control and the Software community
 - Inventory of the existing interface.
 - Analysis of the functional variability by the working group.



SAFI Phase 1

Primes and agencies harmonising Star Trackers functional interfaces



Galileo AASTR

- Number of tracker windows
- Number of SEU filtered
- Covariance_X
- Covariance_Y
- Covariance_Z
- Optic temperature
- TEC current
- Tracking loss counter
- ...

- Final Attitude Quaternion
- Time associated to STR measure for quaternion
- STR mode
- Quality Index of the Attitude
- STR Health status
- Final Angular Rate vector
- Time associated to STR measure for angular rate
- Number of stars used for attitude determination
- Counter since last Reset
- ON command for TEC number n
- Target temperature for TEC number n
- Reset Command
- STR Mode
- Uploaded Date
- Attitude initialisation (Optional)
- Angular rate vector initialisation

Sodern Hydra

- Number of expected stars
- Number of coherent stars
- Quality index X
- Quality index Y
- Quality index Z
- Peltier temperature flag
- ...

- Number of trackable stars
- Number of identified stars
- Number of acquired objects
- Detector temperature
- Optics temperature
- Housing temperature
- TEC mode
- ...

Jenoptik Astro APS

Core data/commands package for any STR

(This core should contain all data/commands used directly on-board by AOCS & FDIR)



Savoir Safi: support activity - Background



- Outcome: functional I/F harmonisation proposal for RW and STR.
- Only Spacecraft prime manufacturers were involved (beside ESA and CNES).
- Following Savoir Safi phase1 a support activity was funded under ESA corporate budget, aimed at:
 - Review and refine the STR functional I/F harmonisation proposal.
 - Involve STR manufacturers together with SC primes.
 - Agree on a harmonised STR functional I/F (only for data exchanged with OBSW).
 - Possibly include the harmonisation as a non-mandatory (informative) annex of *"Stars sensors terminology and performance specification"* (ECSS-E-ST-60-20C) for future STR products.
- Industry involved:
 - STR manufacturers: Galileo Avionica – JenaOptronik – Sodern – Terma
 - SC Primes (already involved in SAFI phase1): AST – OHB – TAS



Savoir Safi: support activity - Events



- Activity K.O. February 2013.
- STR suppliers were involved in Safi STR functional I/F harmonization for the first time: Their feedback has been very enthusiastic and they worked in a very proactive way. There was a general will to extend the harmonization process as far as possible.
- Suppliers provided a first feedback on STR functional I/F harmonisation proposal from Safi phase1: They did not highlight any blocking point or major concern.
- Progress Meeting 1 took place in two sessions: 10 July and 09 September 2013:
 - Only STR Suppliers were involved.
 - The STR functional I/F harmonization has been refined and detailed.
- Final Meeting took place 10 October 2013 at ESTEC.
 - Representatives of all STR suppliers and SC Primes were present.
- **An agreement was found on a common core of STR Functional Interface**
- It is expected to close the activity before the end of the current year.



Savoir Safi: support activity - Approach



General approach:

- STR Output Data includes mandatory and optional parameters.
 - Mandatory parameters must be provided by each STR.
 - Optional parameters can be provided or not by STR, but if provided shall be compliant to the table.
- Commands received by STR are either mandatory or optional.
 - STR shall be able to receive all mandatory commands.
 - Optional commands can be implemented or not by STR, but if implemented they shall be compliant to the table.
- Each STR can implement additional data and command (or same data/command but in other format) provided that this is not replacing any optional or mandatory data/command.
- Each STR ICD shall indicate which optional data parameters and optional commands are supported by the STR and the ones not supported by STR (e.g. applicability matrix).
- Harmonization will take into account only data and commands exchanged between STR and OBSW.
- The harmonized F/I will eventually be part of the E-ST-60-20C standard as a non-mandatory (informative) annex, and is targeting future STR products.



Savoir Safi: support activity – STR data



- The common core of STR F/I contains 9 different STR data comprehensive of all STR information susceptible to be used on board.
- Example: Extract of common core of F/I for STR data:

1- Data provided which each measurement frame containing following parameter (mandatory and optional):

1. Parameter Number	2. Parameter Name (within Data packet)	3. Mandatory / Optional	4. Description	5. Format	6. Unit (IS)
STR D 01 i	QuatSTRwrHIRF_i	i = 0 Mandatory i > 0 Optional	Attitude Quaternion provided by STR i = 0 → STR best estimate (fused measure) i = 1, 2, 3, ..., n+1, n+2, etc. → OH1, OH2, ..., OHn, fused attitude with different post processing, etc.	q = [scalar; vector(3)] Reference frame: i = 0 J2000 frame → STR frame (for i = 0) i > 0 J2000 frame → OH Frame or STR frame Notes: Each STR shall be able to provide the data in the above format. Additional ways to present the quaternion (format and frames) can be provided by the STR (upon customer choice). No constraint on quaternion components sign.	-
STR D 02 i	DateQuat_i	i = 0 Mandatory i > 0 Optional	Time associated to STR measure for quaternion (STR D 01 i) i = 0 → STR best estimate (fused measure) i = 1, 2, 3, ..., n+1, n+2, etc. → OH1, OH2, ..., OHn, fused attitude with different post processing, etc	Default: Time elapsed between the last synchronisation signal and attitude measurement. Option (non mandatory): STR propagated time in CCSDS Unsegmented Code (CUC) time code format. Note: Both Default and Option formats are not intended to constrain the way the STR is working i.e. free running or synchronised.	s (scalable)
STR D 03 i	RateSTRwrHIRF_STR_i	Optional	Final Angular Rate vector provided by STR i = 0 → STR best estimate (fused measure) i = 1, 2, 3, ..., n+1, n+2, etc. → OH1, OH2, ..., OHn, fused measure with different post processing, etc.	w = vector(3) STR frame wrt Inertial Frame i = 0 w = vector expressed in STR frame i > 0 w = vector expressed in OH or STR frame	Rad/s
STR D 04 i	DateRate_i	Optional	Time associated to STR measure for angular rate (STR D 03 i) i = 0 → STR best estimate (fused measure) i = 1, 2, 3, ..., n+1, n+2, etc. → OH1, OH2, ..., OHn, fused measure with different post processing, etc.	Default: Time elapsed between the last synchronisation signal and attitude measurement. Option (non mandatory): STR propagated time in CCSDS Unsegmented Code (CUC) time code format.	s (scalable)

Savoir Safi: support activity – STR command



- The common core of STR F/I contains 7 different STR commands comprehensive of all STR commands susceptible to be used autonomously on board.
- Example: Extract of common core of F/I for STR commands:

2- Commands (mandatory and optional) containing various parameters.

1. Command Number	2.1 Command Name	2.2 Parameter Name (within command)	3. Command Mandatory / Optional	4. Description	5. Format	6. Unit
STR C 01	<u>CmdReset</u>	<u>Reset_type</u>	Mandatory	Reset Command (Typically a number in order to give the possibility to perform different type of reset)	<u>Reset_type</u> = 0 Reset command of the complete STR (mandatory). <u>Reset_type</u> > 0 Other reset command (optional).	-
STR C 02	<u>CmdTEC</u>	1 - <u>TEC_ON_OFF</u>	Optional (in case of no TEC)	ON/OFF command for TEC number n	TEC_ON_OFF = ON/OFF command for OH n	-
		2 - n (Head number)			n = TEC of Optical Head number n (n = 0 → for all OH) (n > nb, OH → command ignored)	-
		3 - <u>TEC_Tmp</u>			Target temperature in °C	°C
STR C 03	<u>UploadDate</u>	Date	Optional	Upload Date to STR	CCSDS <u>Unsegmented</u> Code (CUC) time code format This command shall be implemented according to the communication layer standard, if any.	s (scalable)
STR C 04	<u>CmdStandbyMode</u>	n	Mandatory	If STR ON → switch from current mode to STR Standby Mode	n = 0 → STR standby mode (all OH), Mandatory.	-

Savoir Safi: support activity - Conclusion



- **An agreement has been found between European STR suppliers, European Spacecraft primes and the Agency on a common core of STR functional interfaces.**
- The standard will be eventually a non mandatory (informative) annex of ECSS-E-ST-60-20C.
 - In the frame of a document revision to be planned in 2014.
- This process may be applied to other AOCS H/W.
 - E.g. gyros (to be discussed in the ECSS WG), Reaction Wheels (in view of future developments).
- The agency would like to thank the representatives of the industry involved in the support activity for their proactive contribution and their enthusiasm towards the standardization process.

