SAVOIR UNION

space avionics open interface architecture

Status ADCSS 2018

Savoir-UNION Tasks

- UNION stands for User Needs In Onboard Network

- The SAVOIR-UNION Working Group shall have as a main goal the review of the functional, performance, operational and interface requirements of the functional links and their management defined within the OSRA-Net activity.

- The scope is currently:
  - limited to the identification and characterization of the needs of users in term of communication,
  - does not address the communication physical standards,
  - does not address the communication protocols.

SAVOIR-Union Members

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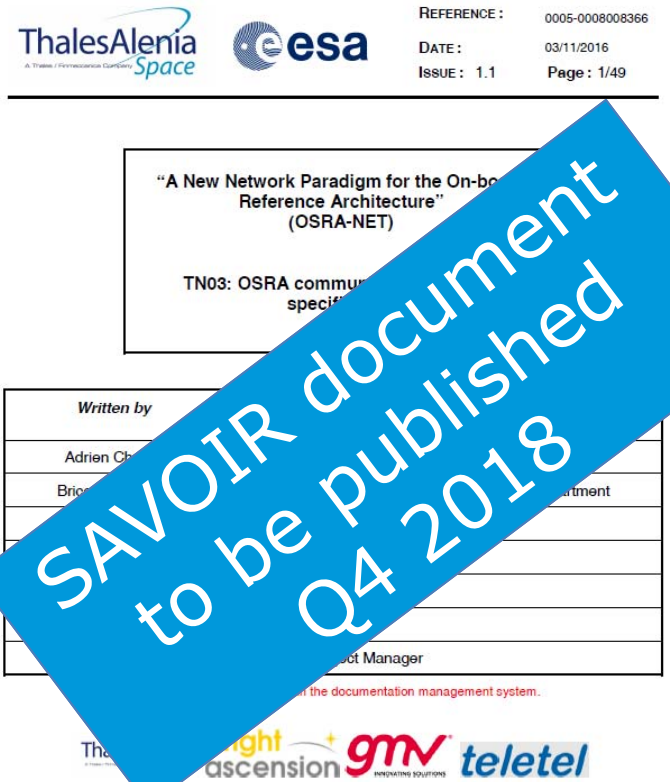
Communication network specification



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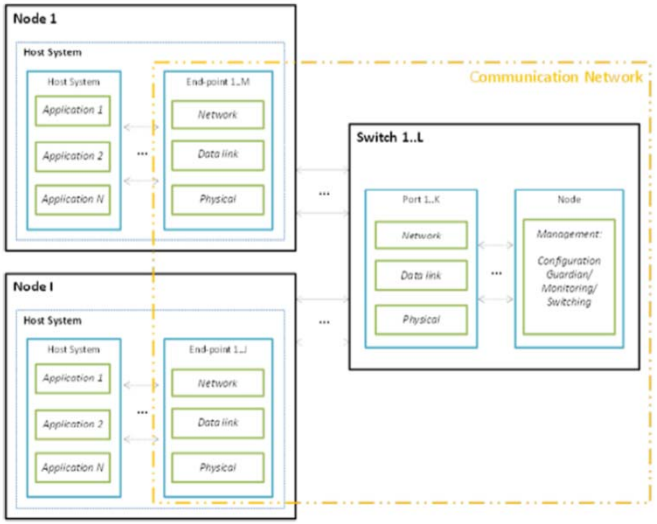


COMMUNICATION SYSTEM CAPABILITIES REQUIREMENTS
- Generic capabilities
- Quality of Service requirements
- Class of communication requirements

COMMUNICATION INFRASTRUCTURE REQUIREMENTS

ERROR HANDLING AND FDIR REQUIREMENTS

SYSTEM-LEVEL COMMUNICATION REQUIREMENTS

USE CASE

	Traffic description														
	Equipment	Data type	Max Cargo size (bits)	Frequency (Hz)	Period (ms)	bit rate	AOCS sensitivity	Jitter requirement		Latency (ms)		Other requirements	QoS level	Time stamp (8 octets)	Proposed Class of Comm
								Value (ms)	ROM	Value (ms)	ROM				
Sensors	Magnetometers	AOCS	12	8	125	100 bits/s	> 1 cycle	1000	1 cycle	1000	1 cycle	order of msg		No	2
	Coarse Sun Sensors	AOCS	96	8	125,00	770 bits/s	Low	10	1 cycle	10	1 cycle	order of msg		No	2
	Gyro (Coarse/safe mode)	AOCS	576	8	125,00	4,6 kbits/s	1 cycle	2	1 cycle	2	1 cycle	order of msg		No	
	Gyro (fine-grained)	AOCS	576	32	31,25	18 kbits/s	1 cycle	2	< 1 Cycle	2	< 1 Cycle			Yes	8
	Gyro (future)	AOCS	576	32	31,25	18 kbits/s	1 cycle	2	< 1 Cycle	1	< 1 Cycle			TBD	8
	Star-Tracker (Smart)	AOCS	8194 - 32777	8	125,00	65 to 262 kbits/s	1 cycle	1	< 1 Cycle	10	1 cycle			Yes	2
	Star-Tracker (Smart)	AOCS - Geo	8194 - 32777	8	125,00	65 to 262 kbits/s	> 1 cycle	2	1 cycle	10	> 1 cycle			TBD	2
	Star-Tracker	AOCS - Agility	8194 - 32777	30	33,33	245 to 983 kbits/s	<< 1 Cycle	0	<< 1 Cycle	1	<< 1 Cycle			Yes	5
	Camera - High Res.	AOCS - Rendez-vous	41943040	8	125,00	335 Mbits/s	1 cycle	10	< 1 Cycle	100	1 cycle			Yes	6
	Camera	AOCS - Nav. Cam	10485760	8	125,00	84 Mbits/s	> 1 cycle	100	> 1 cycle	100	> 1 cycle			Yes	4
	Camera	AOCS - Multi stage (1kHz)	1000000	1000	1,00	1000 Mbits/s	> 1 cycle	100		100				Yes	6
	IR Spectrum Camera	AOCS	2457600	1	1000,00	2,5 Mbits/s	> 1 cycle	100		100				Yes	6
	Payload sensors	Various - closed loop	Mission dependant	100	10,00	Mission dependant	<< 1 Cycle	Mission dependant	<< 1 Cycle	Mission dependant	<< 1 Cycle			TBD	5
	Tachometer	AOCS	30720	8	125,00	245 kbits/s	> 1 cycle	10	> 1 cycle	100	> 1 cycle			No	3
	Tachometer	AOCS - Agility Multi stage	Time stamp could be greater than actual value	100	10,00	TBD	1 cycle	1	< 1 Cycle		< 1 Cycle		1	Yes	5
	GNSS	AOCS	10000	1	1000,00	10 kbits/s	1 cycle	10	1 Cycle	10	1 Cycle			Yes	1
		AOCS	14	1	1000,00	10 kbits/s	1 cycle	0,001	<< 1 Cycle	0,001	<< 1 Cycle			Yes	1
Actuators	Magneto-Torquer Bars	AOCS	12	0,125	8000,00	neglectable	1 cycle	500	< 1 Cycle	8000	1 cycle		1 or 2	No	1
	Thrusters (x28)	ACOS	2800	8	125,00	22 kbits/s	<1 cycle	Mission dependant		Mission dependant			1 or 2	No	3
	Thrusters - chemical	ACOS	2800	256	3,91	720 kbits/s	< 1 cycle	0,1	<1 Cycle	0,1	<1 Cycle	no loss	2	TBD	5
	Thrusters -electrical	ACOS	No hard constraints due to propulsion cycles: several minutes and the imapct on trajectory is not immediate										1 or 2	TBD	1
	Reaction Wheels	AOCS	30720	8	125,00	250 kbits/s	1 cycle	10,00	< 1 Cycle	10,00	1 cycle		1 or 2	Yes for some	2
	Reaction Wheels (high speed)	AOCS -Agility	30720	100	10,00	3 Mbits/s	1 cycle	0,50	< 1 Cycle	1,00	< 1 Cycle	No Loss of msg End of process in same cycle	2	TBD	5
Payload	Spectrometer	Science	2,00E+08	10	100,00	2000 Mbits/s	N/A	N/A	N/A	N/A	N/A		0 or 1	No	4
	Ultra HD Camera (4K)	Science	9,95E+07	10	100,00	1000 Mbits/s	N/A	N/A	N/A	N/A	N/A		0 or 1	No	4
	X Ray detector	Science	1,80E+10	0,0303	33003,30	545 Mbits/s	N/A	N/A	N/A	N/A	N/A		0 or 1	No	4

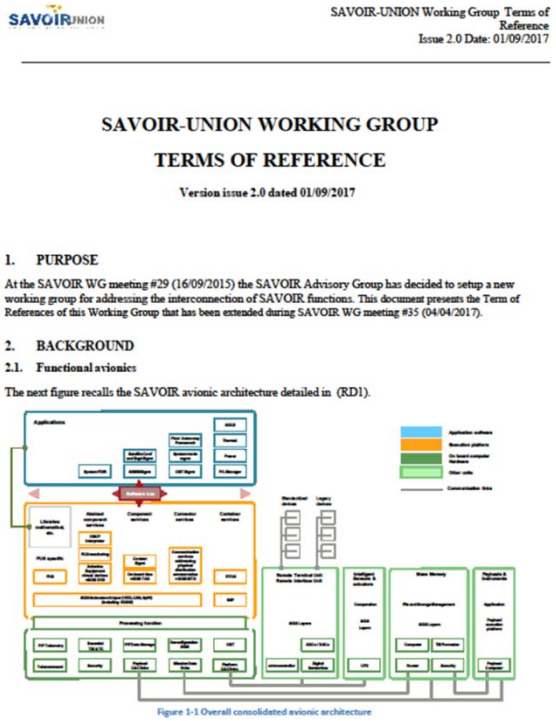
Avionics Embedded System Dossier

- One activity OSRA-ION has been placed in the roadmap as a follow-on of the OSRA-Net activity.
- It addresses
  - the development of tools that support the modelling and analyses required to perform the trade-offs of communication networks, buses and links;
  - the demonstration of the tools through two different Use Cases.
    - The first Use Case shall consist in the modelling and the analysis of the architecture of an existing spacecraft for what concern communications.
    - The second Use Case shall consist in updating the model to be representative of future spacecrafts and the generation of the related sets of requirements.

- **Proposed to IPC, should start in 2019**

SAVOIR-UNION ToR extension

- An extension of the ToR of the SAVOIR-UNION Working Group is proposed in order to prepare and follow the future activity.
- Before the preparation of the Statement of Work:
  - Identify the set of communication links and protocols to be considered (1553, CAN, SpW, SpFi, …)
  - Identify their characteristics w.r.t. SAVOIR-UNION requirements.
- During the execution of the study:
  - Review the results of the study and provide recommendations


SAVOIR-UNION Working Group Terms of Reference
Issue 2.0 Date: 01/09/2017

SAVOIR-UNION WORKING GROUP

TERMS OF REFERENCE

Version issue 2.0 dated 01/09/2017

1. PURPOSE

At the SAVOIR WG meeting #29 (16/09/2015) the SAVOIR Advisory Group has decided to setup a new working group for addressing the interconnection of SAVOIR functions. This document presents the Term of References of this Working Group that has been extended during SAVOIR WG meeting #35 (04/04/2017).

2. BACKGROUND

2.1. Functional avionics

The next figure recalls the SAVOIR avionic architecture detailed in (RD1).

Figure 1-1 Overall consolidated avionic architecture

1

Meanwhile … preparation of the roadmap

- Several technologies are competing for command and control buses:
  - 1553
  - CAN
  - SpaceWire(-D[+], RMAP, STP-ISS)
  - SpaceFiber
  - TTEthernet
  - TSN, …
- Coverage of SAVOIR UNION requirements are different as well as standardization level, maturity, cost, …
- Resources are limited and then optimization is important.

Characterisation of solutions

- In order to characterize the different solutions, around 40 attributes have been identified including:
  - Compliance to OSRA-Net requirements
  - Technical: Topology/#Users, Mass, Power, Throughput, Format, Complexity, Reliability, Tolerance to radiations, …
  - Programmatic: Standardisation (and influence level), TRL, Perennity, tool support, …
  - Cost: Flight parts as well as tools for development and verification.

Overview of statement of compliance

- OSRA-Net classes of communication:

Class	Description	Freq min	Freq max	QoS 0	QoS 1	QoS 2	Rate min	Rate max	Jitter	Latency
1	Low frequency, small / medium data size, non time critical	0.1	1	x	x		100E+0	10E+3	10	10
2	Medium frequency, Medium data size, time critical, medium QoS	8	10		x	x		1E+6	5	10
3	Medium frequency, Medium data size, time critical, high QoS	8	10			x		250E+3	10	10
4	Low frequency, Big data size, non time critical, low QoS	0.1	1	x	x		100E+6	1E+9	100	100
5	High frequency, Medium data size, time critical, medium QoS	10	1000		x	x		3E+6	0.5	0.5
6	Medium frequency, Big data size, time critical, medium QoS	1	10		x	x	100E+6	250E+6	2	10
7	Medium frequency, Small data size, time critical, low jitter, high QoS	1	10	x	x		100E+0	1E+3	1	2

- Bus and protocol capabilities coverage of SAVOIR-UNION/OSRA-Net requirements.

	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5	Cat 6	Cat 7
CAN	☺	😐	😐	☹	☹	☹	?
1553	☺	😐	☺	😐	☹	☹	☺
SpW-Net	😐	☹	☹	😐	☹	☹	☹
SpW-D+	😐	☺	☺	😐	😐	?	😐
SpFi-Net	😐	😐	☺	☺	☺	☺	😐
TSN	😐	☺	☺	☺	?	😐	☺
TTE	😐	☺	☺	☺	☺	?	☺

☺	Fully fit the need
😐	Fits the need, possibly overdoing or with some restrictions
☹	Does not fit
?	Not known/To be confirmed

Particular highlights

- CAN will consolidate its domain of application (small systems and payloads).
- 1553 is reaching its limits and will/shall be replaced to support future applications.
- SpW network deterministic protocol still to be defined.
- SpFi network available soon for small networks (e.g. payloads)
- SpFi network for large networks would benefit SpW deterministic protocol.
- TTEthernet is available for launchers, applicability for spacecrafts to be assessed.
- TSN seems promising, need qualification for space, applicability for spacecraft to be assessed.

And now it's your turn

- A complete session is dedicated tomorrow.

09:00 → 13:00 **Command & Control Interfaces: status quo and medium/long term evolution** — Tennis Hall (Escape Building)

09:00	**Welcome** **Speaker**: Mr Ali Zadeh (ESA)	5m
09:05	**Need and Evolution of C&C** **Speaker**: Mr Giorgio Magistrati (ESA/Data Systems Division)	10m
09:15	**ESA Programs Views**	2h
11:15	**Coffee Break**	25m
11:40	**Primes Views** ▪ Airbus Defence and Space by Mr. R. Roques ▪ Thales Alenia Space by Mr. B. Dellandrea ▪ Current Spacecraft Data Handling Interfaces and Future Needs at OHB by Mr. D. Felbach	1h
12:40	**Round Table and Wrap-Up** **Speaker**: Dr Wahida Gasti (TEC-EDD)	20m

- Speak now or keep quiet for next decade(s).