Avionics-Power interfaces standardisation
An exportable approach?

Power and Avionic Work Group*

Presented by

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16/10/2020

* Participants revealed in slide 13

Avionics-Power interfaces standardisation

Outline

- Preamble
- Motivation
- Subjects and objectives
- WG
- Methods
- Work in progress
- Conclusions.....slide 22

Avionics-Power interfaces / PREAMBLE

Acronyms

- **ADHA** Advanced Data Handling Architecture parallel studies (RUAG/ADS, TAS-I)
- **DOD** Depth of Discharge
- **OBDH** On-board Data Handling (SubSystem)
- **EPS** Electrical Power SubSystem
- **MBSE** Model Based System Engineering
- **MPPT** Maximum Power Point Tracker
- **PCDU** Power Conditioning and Distribution Unit
- **S3R** Sequential Shunt Switching Regulator
- **SA** Solar Array
- **SADE** Solar Array Drive Electronics
- **SADM** Solar Array Drive Mechanism
- **SAR** Solar Array Regulator
- **SOC** State of Charge
- **SOH** State of Health

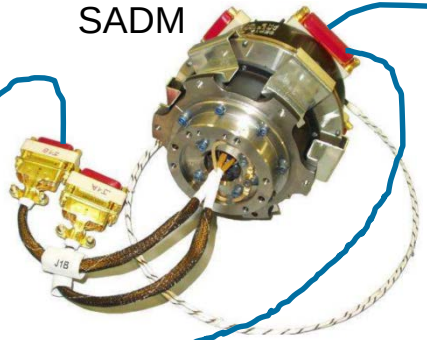
(Key) definitions

- **Observability of a system**
  A system is said to be **observable** if its current state can be estimated using only the information from its outputs.
  In other words, one can determine the behaviour of the entire system from the system's outputs.
- **Functional / logical view**
  The perspective of a system that identifies its functionality *without* specifying the physical allocation of the relevant functions
- **Physical view**
  The perspective of a system that identifies its functionality *including* the physical allocation of the relevant functions

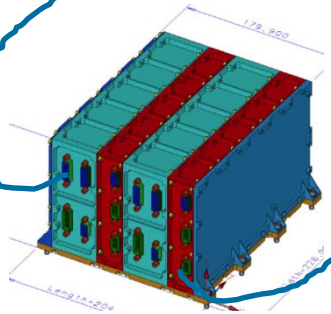
Electrical Power subsystem – a real view

Solar Array

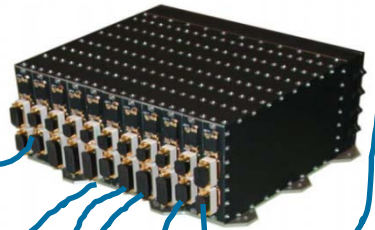
SADM



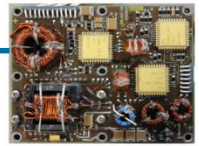
SADE

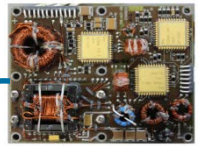


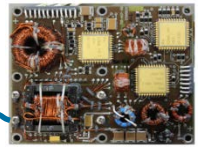
PCDU



Secondary DC/DC converters





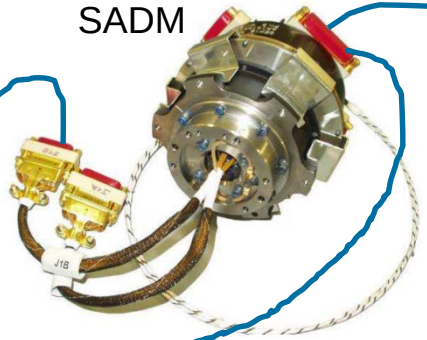


Battery

Electrical Power subsystem

Solar Array

SADM



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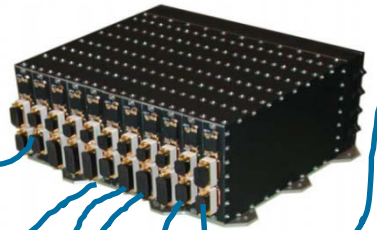

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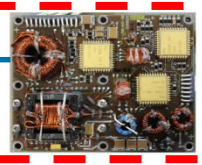
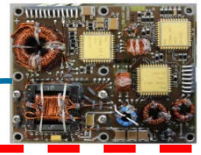
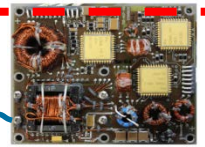


Equipment 1

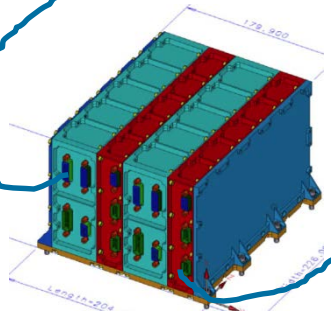


Equipment 2



Equipment n

SADE



Battery

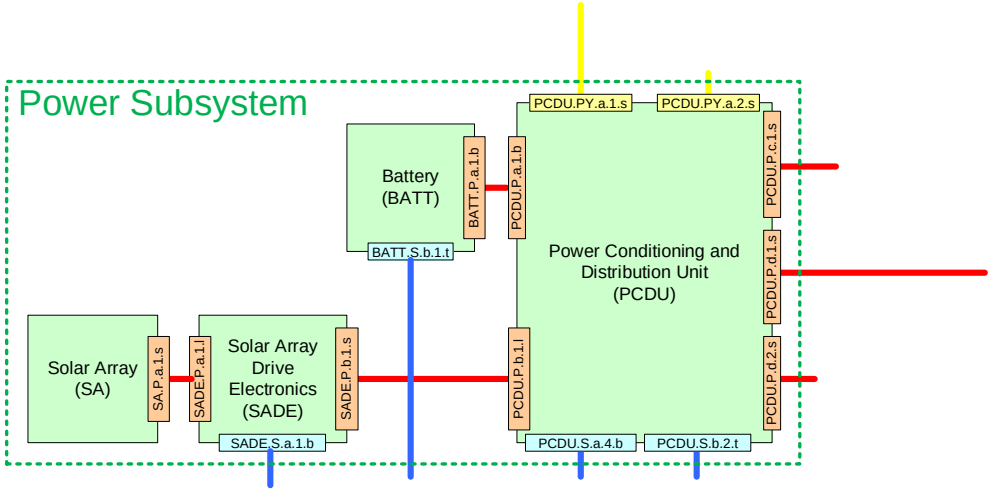
Electrical Power Subsystem (EPS)

Electrical Power Subsystem variability

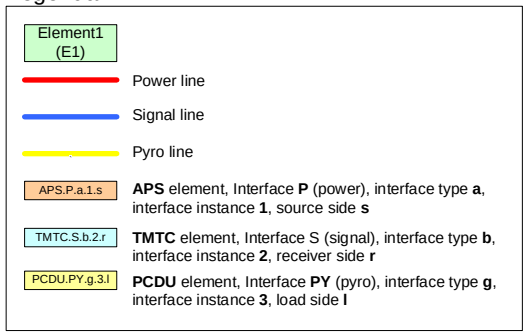
- Many variants, according to mission (environment, orbits)
  - Different solar arrays
  - Different batteries
  - Different PCDUs with different internal architectures
    - Regulated or unregulated bus
    - 28V, 50V, 100V regulated; around 28V or 50V unregulated (but not real standard)
  - Different or no SADM/SADE…
  - Different distribution lines (for essential, non essential equipment, heater lines, etc)

Power Subsystem Reference Architecture … (to be continued)

- It makes sense to be as general as possible…



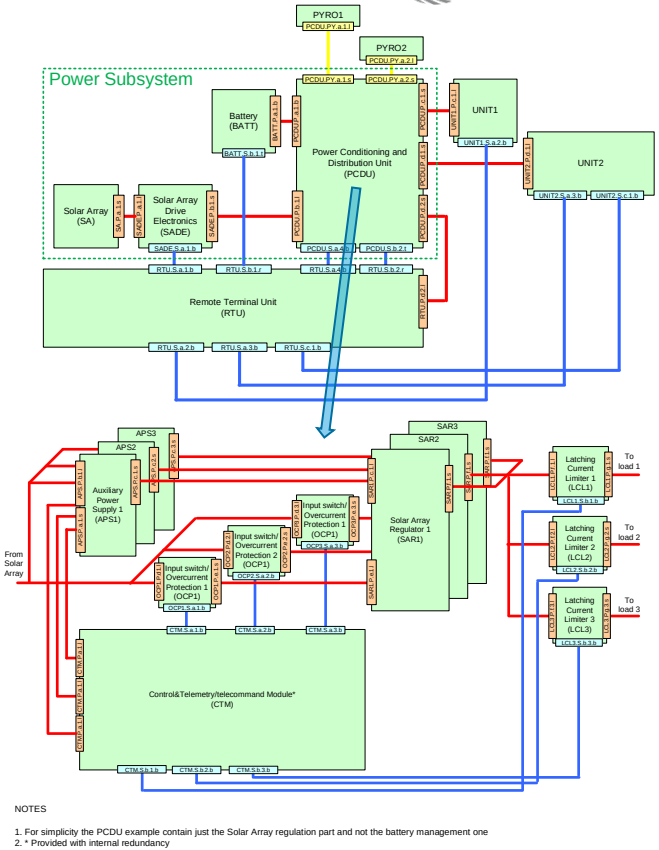
Legenda



Avionics-Power interfaces / MOTIVATION

=> Standardisation effort

- At interface level
- As a first step towards more recurrent products
- With a realistic attitude based on consensus
- Making treasure of previous successful experiences
- With the aim to be MBSE ready!



Avionics-Power interface / SUBJECTS AND OBJECTIVES

Power Interfaces Standardisation – The approach used so far…

- Gives account of Power Subsystem **large variability**

- **Realistic**
  - Covering those interfaces that are actually already largely used in applications
  - No projection of too idealistic / too theoretical ideas

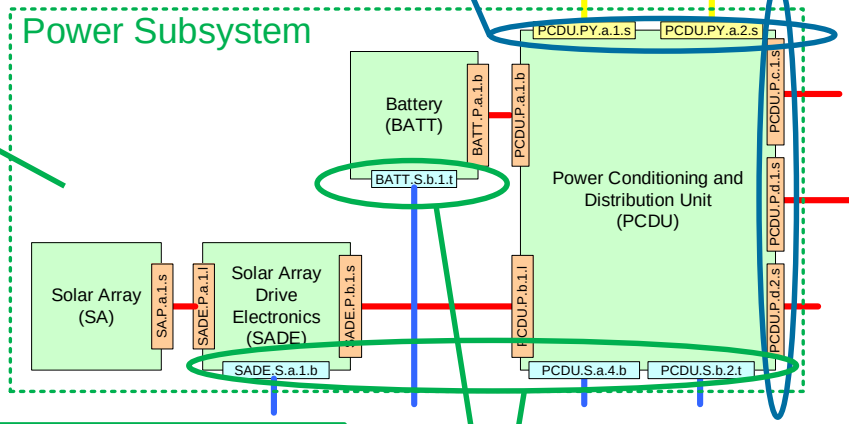
- **Opportunistic**
  - Covering those (mature) interfaces for which standardization seems possible
  - Considering that effective standardization is consensus based

Power Interfaces Standardisation – key topics

Actuators power interfaces (source and load) ECSS-E-ST&HB-20-21, 2019

Failure Detection, Isolation and Recovery

Power distribution interfaces (source & load) based on Latching Current Limiters ECSS-E-ST&HB-20-20, 2016



Legenda

Element1 (E1)

Power line

Signal line

Pyro line

APS.P.a.1.s — **APS** element, Interface **P** (power), interface type **a**, interface instance **1**, source side **s**

TMTC.S.b.2.r — **TMTC** element, Interface S (signal), interface type **b**, interface instance **2**, receiver side **r**

PCDU.PY.g.3.l — **PCDU** element, Interface **PY** (pyro), interface type **g**, interface instance **3**, load side **l**

TM / TC interfaces

\+ Secondary power distribution

Power interfaces and SAVOIR, Prerequisites

- Identification and agreement on electrical **power subsystem reference architectures**
- Cooperation with any standardisation activity concerning **back plane definition for avionic equipment** (ADHA, other)

Avionics-Power interfaces / (SAVOIR)WORKING GROUP

ToR agreed mid March 2020

Participation

ADS, N. Neugnot, J,. Seronie-Vivien

CNES, C. Elisabelair

DLR, N. Aksteiner

ESA, S. Landstroem, O. Mourra, F. Tonicello

OHB, J. Caudepon

RUAG, H. Myllymaki

SENER, C. Tato

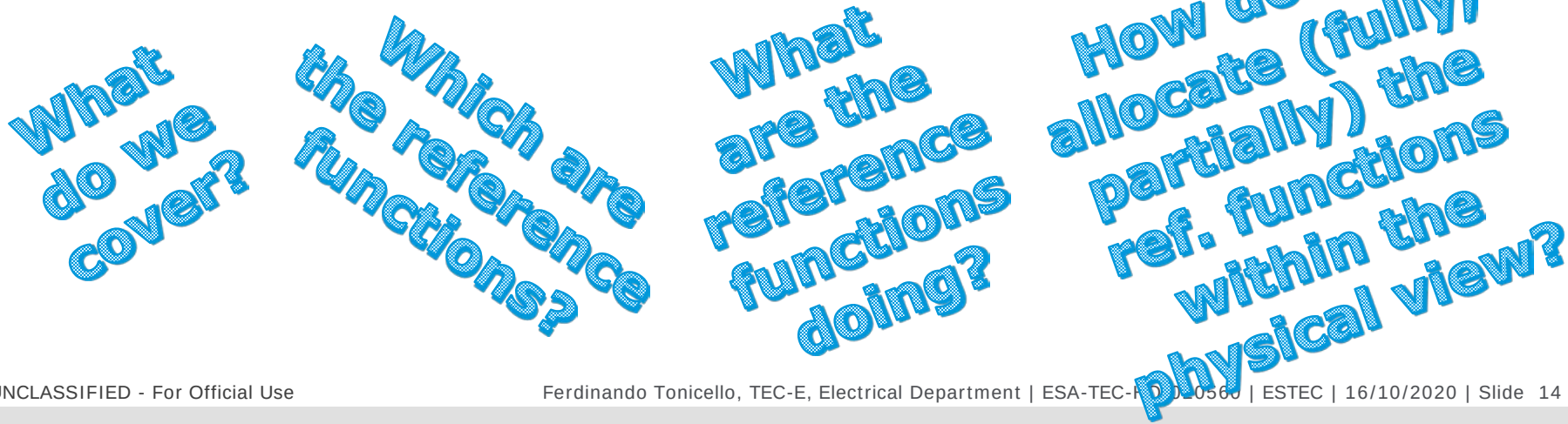
TAS, G. Bouhours, J.L. Bolsee

7 Web-meetings performed so far

Avionics-Power interface / METHODS

Reference architecture definition!

- Two step approach, **functional / logical** layer first, **physical** layer after that
- Most importance given to the precise correspondence of **verbal** definitions and assumptions with the relevant **reference block diagrams**



Avionics-Power interface / METHODS

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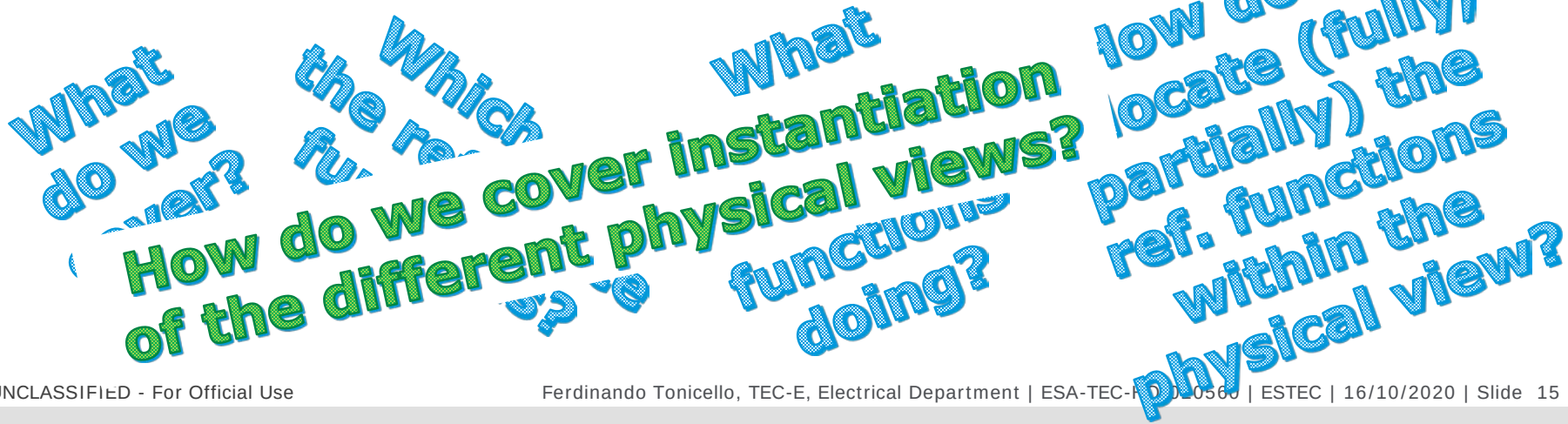


Avionics-Power interface / METHODS / in practice…

1. Broad system/subsystem functional/logical definition

2. Relevant (verbal) functions functional/logical description (as exhaustive as possible)

Example

Power conditioning
is the function of the power subsystem dedicated to the conversion of power coming from power generation, and from or to energy storage to the power bus. The power conditioning function is regulated by the power control function.

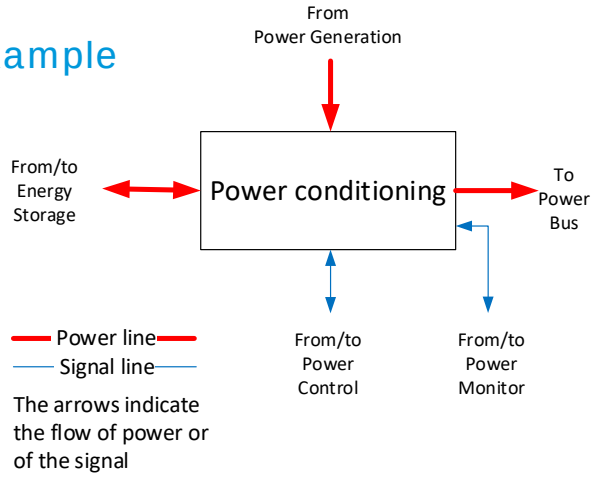
Avionics-Power interface / METHODS / in practice…

1. Broad system/subsystem functional/logical definition

2. Relevant (verbal) functions functional/logical description (as exhaustive as possible)

3. Block diagram (“twin”) functional/logical function description

Example



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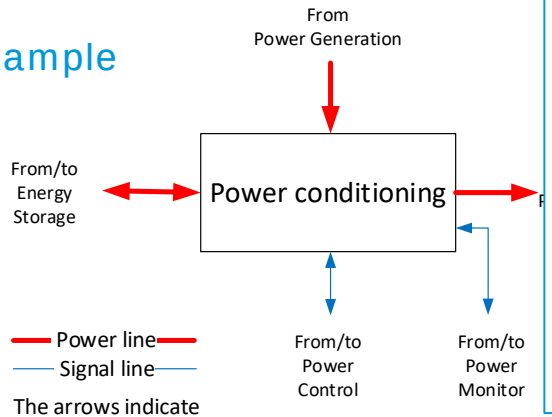

4. **Overall** Block diagram (“twin”) functional/logical function description

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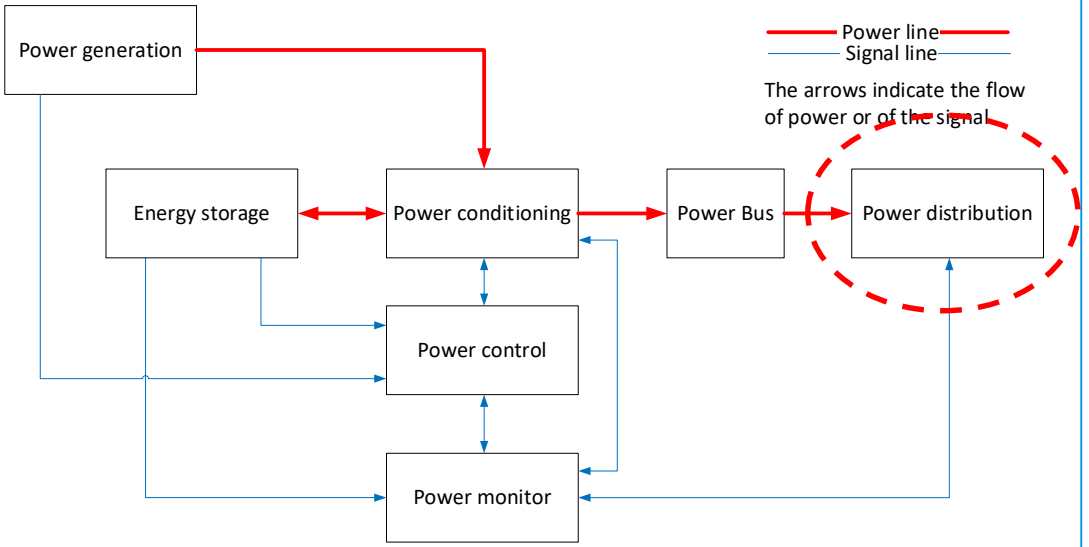

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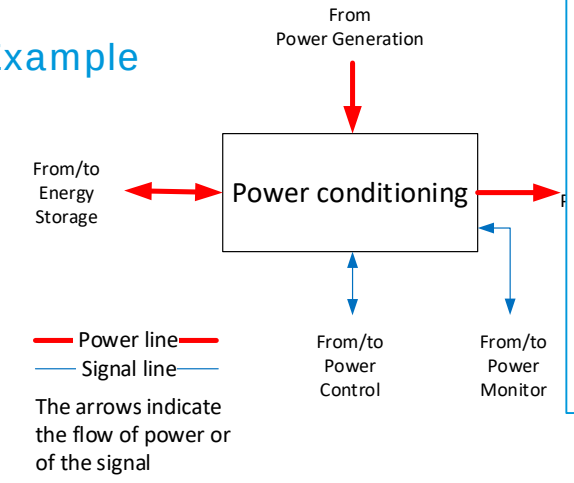
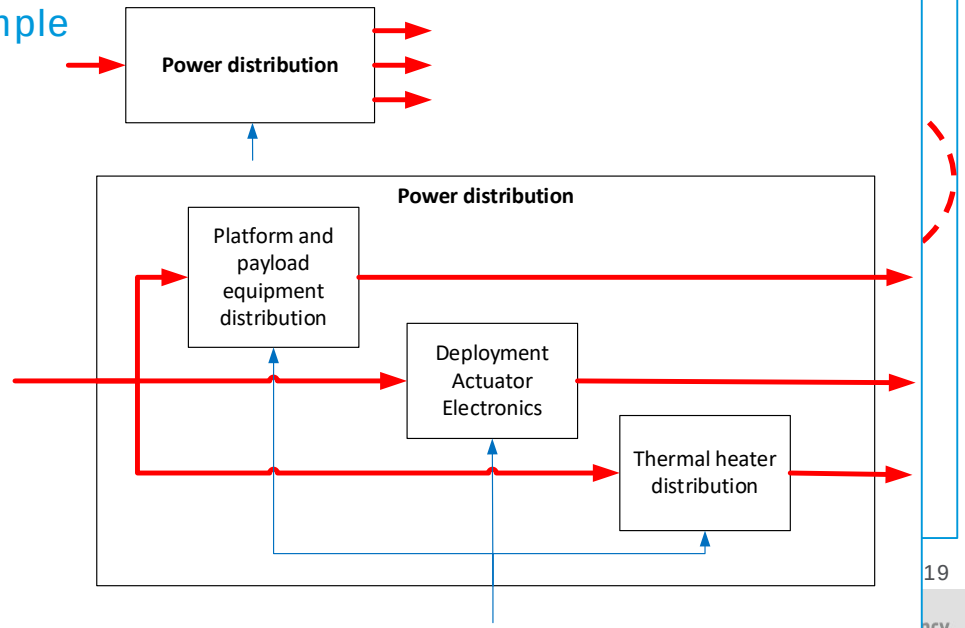


4. **Overall** Block diagram (“twin”) functional/logical function description

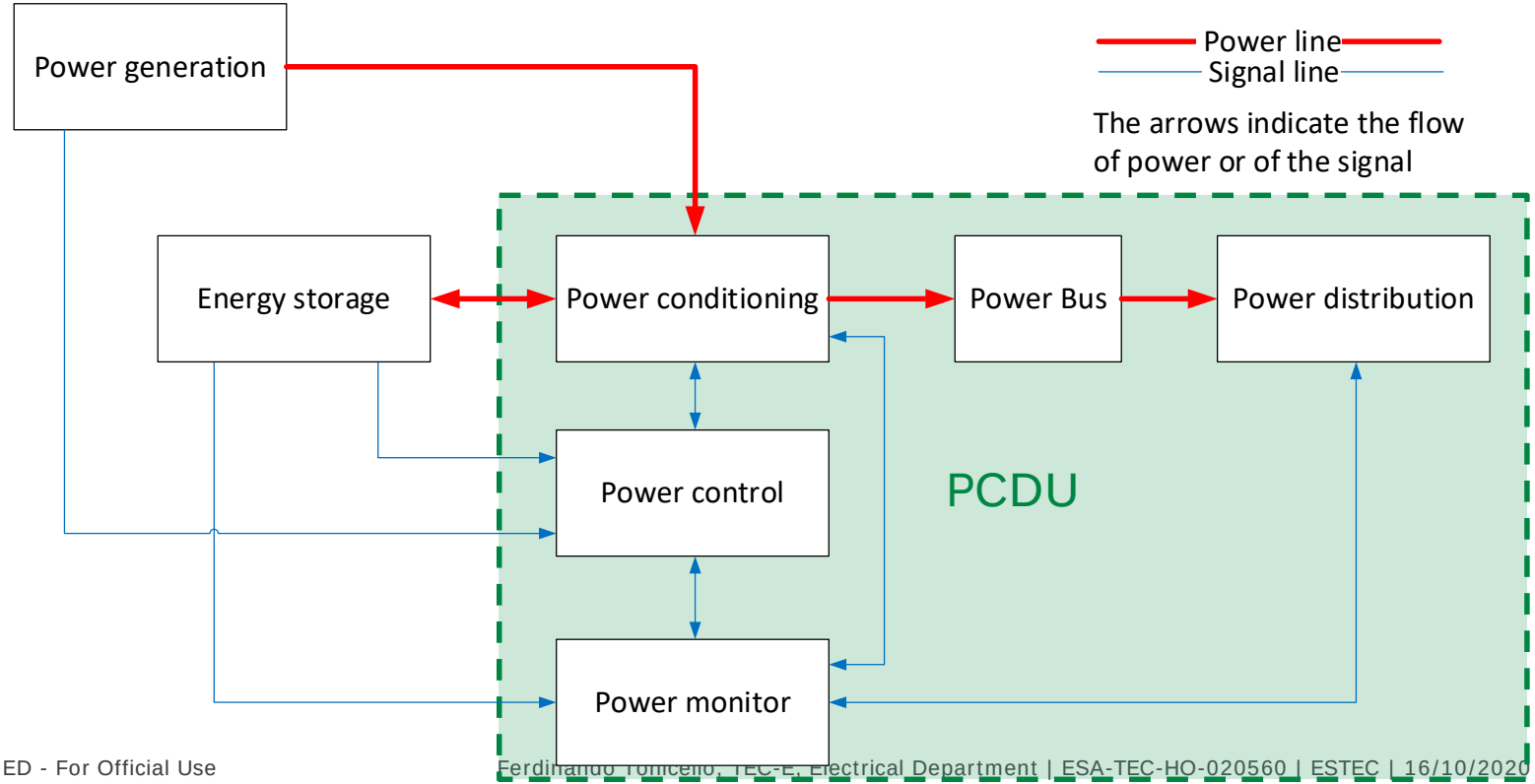
5. “**Get inside the box**”, functional/logical function description

Example



Avionics-Power interface / METHODS / in practice…

From functional/logical to physical block diagram / ”allocation”



Avionics-Power interface / METHODS / in practice…

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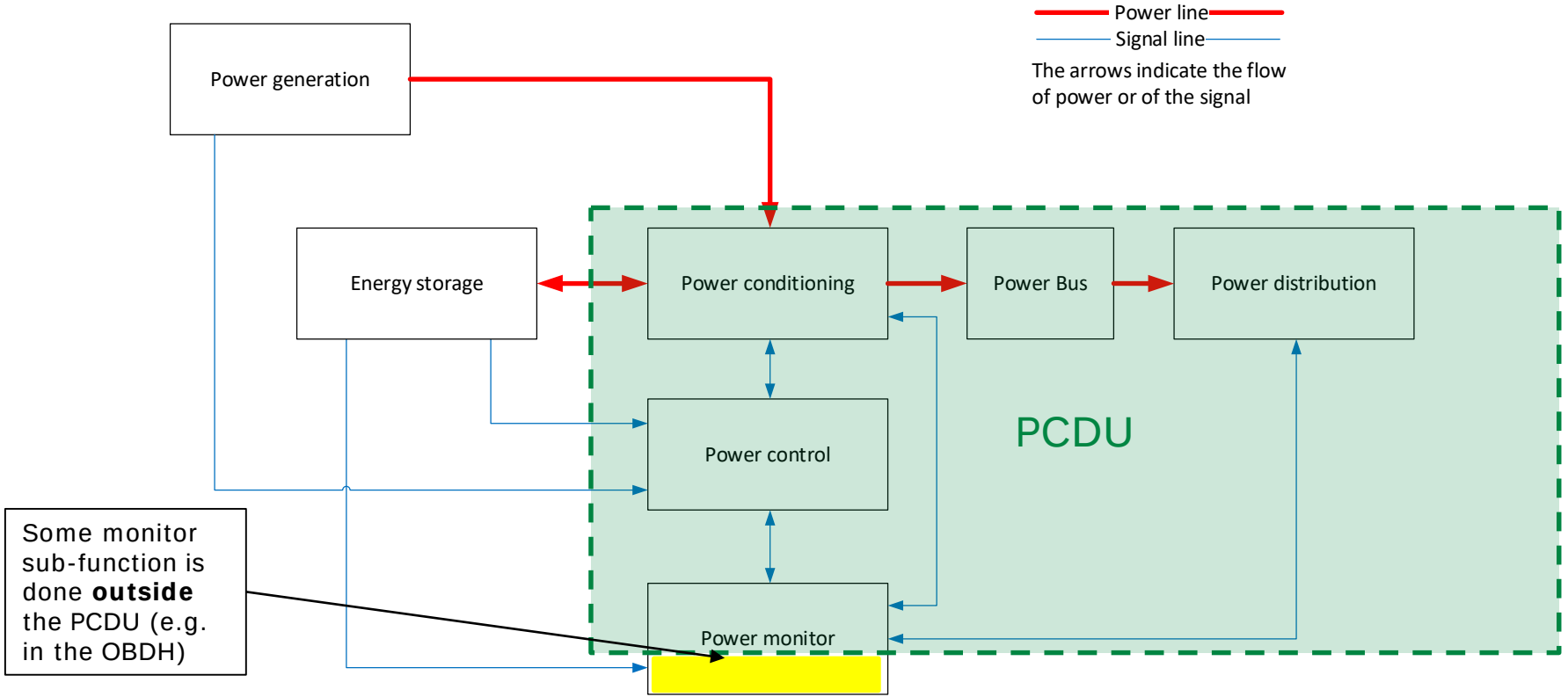

Avionics-Power interface / METHODS / in practice…

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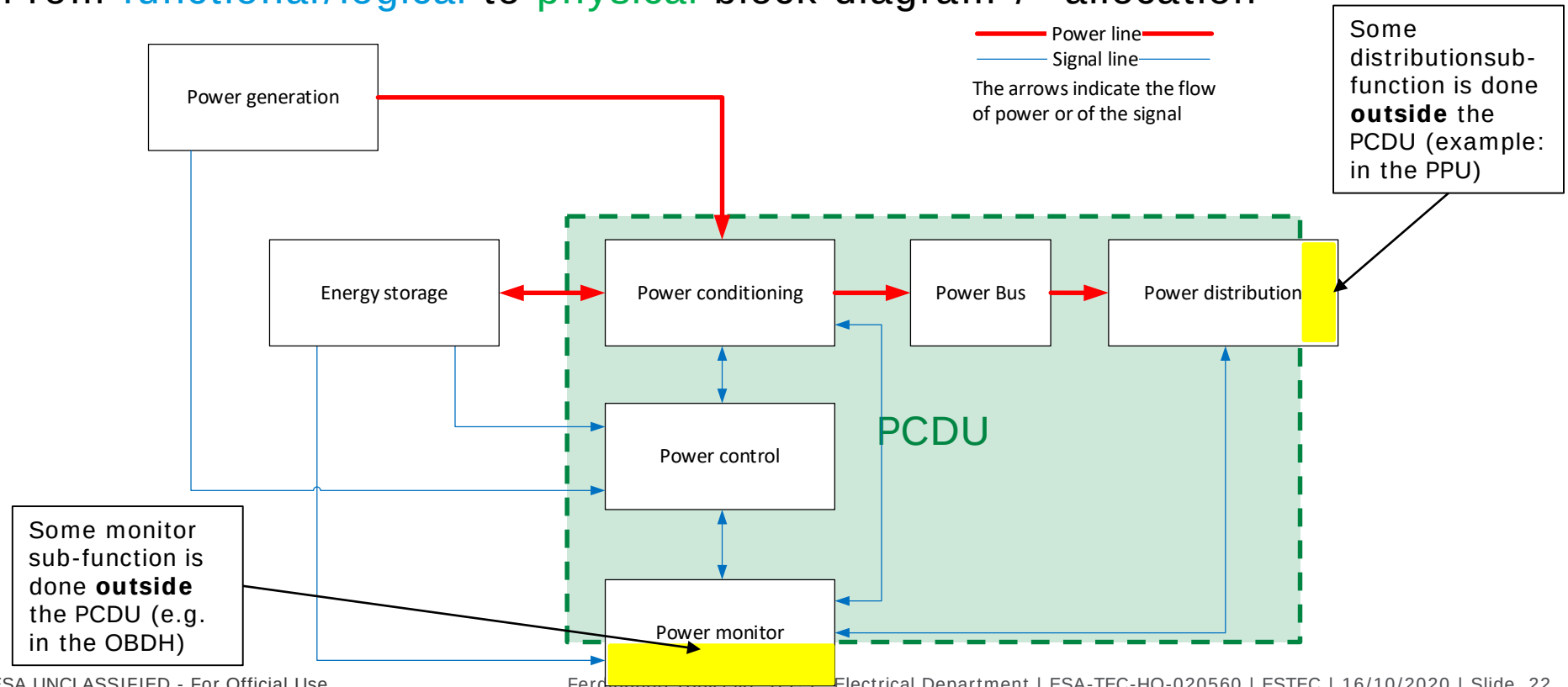
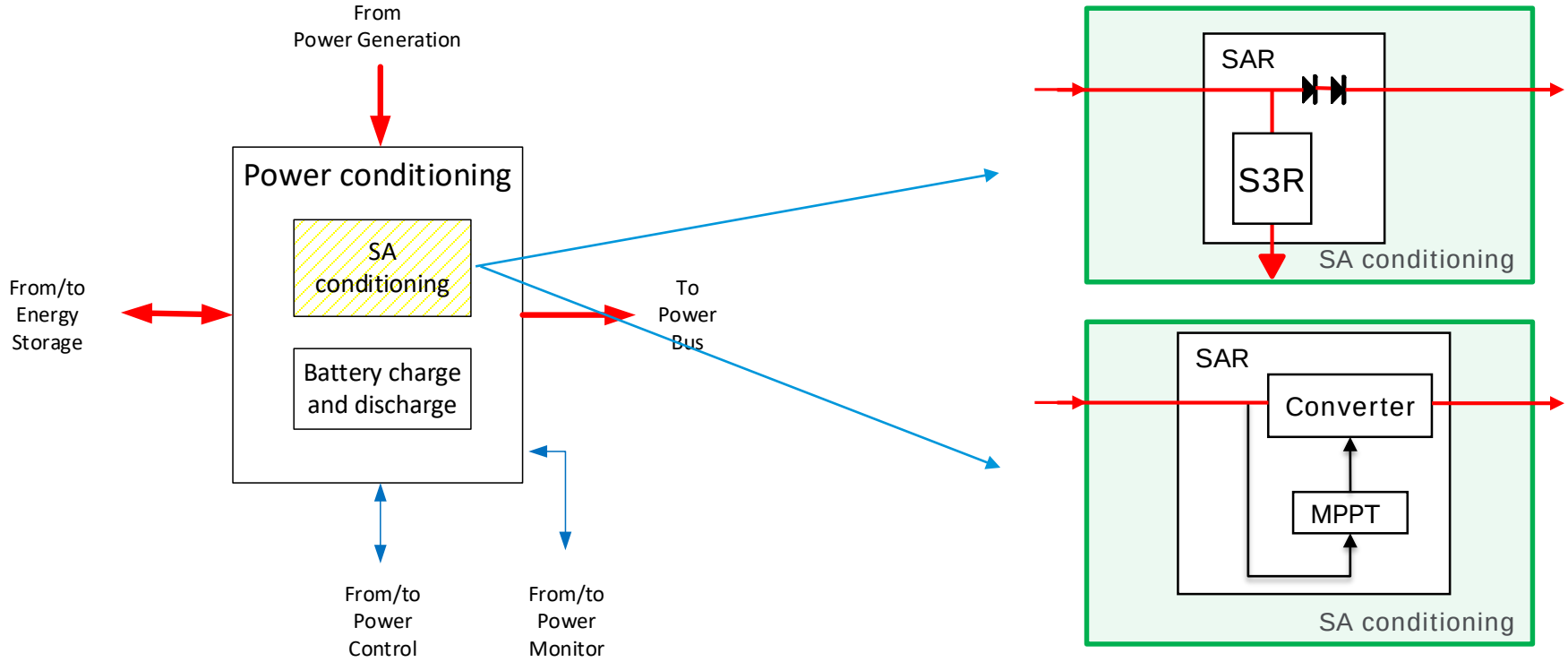


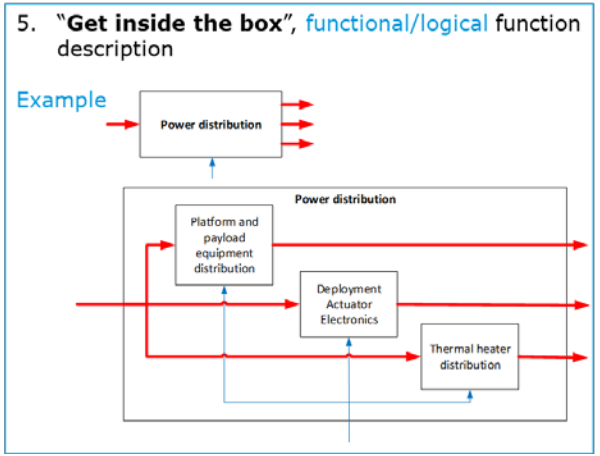
Avionics-Power interface / METHODS / in practice…

Instantiation of physical functions, where interfaces are impacted



Avionics-Power interface / WORK IN PROGRESS

- Reaching agreement on
  - Functional/logical EPS description, including both nominal and contingency aspects
  - The level of depth to go to (see “Get inside the box” , slide 15)
  - Possible instantiation options on EPS physical view



- Starting to identify the observability and commandability needs of all Primes/LSI and translate this need into standard interfaces where possible and convenient

Avionics-Power interface / WORK IN PROGRESS / example

Discussion on

EPS observable items, as an input for the agreed telemetry set (and the relevant interfaces, according to possible instantiation of the physical layer)

Observable items	Information available for Flight/Ground/AIT purposes	Processing	Accuracy
Battery DOD	Flight	second	±3% of DOD
Battery SOC	Flight	second	±5% of SOC
Battery SOH	Ground	month	±3% of SOH
Battery internal impedance (DC, AC)	Ground	hour	±10% of full scale
Battery temperature	Ground	minute	±2°C
SA instantaneaous output power	Ground	second	±3% of full scale
SA available power (of possible)	Ground	second	±3% of full scale
…	…	…	…
…	…	…	…

Primary focus on the functional requirements and not in the design specification

Avionics-Power interface / CONCLUSIONS

Too early to have some definitive conclusions, but…

1. We identified a workable way to have a MBSE ready approach to reference architecture! (see “ METHOD” slides)

2. Whatever the level of interface definition we will achieve, it will be agreed by European Large System Integrators, European Agencies and by some of the most important power equipment manufacturers and users

3. This (interesting) work continues…