Update on the FIDES method in the frame of its application to Space

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1. The FIDES method – reminder of what it is and why it is considered for Space applications

2. Evolutions since 2016, current situation and perspectives for FIDES

3. Updates on ADS and the European space community wrt FIDES

4. Ongoing actions and way forward

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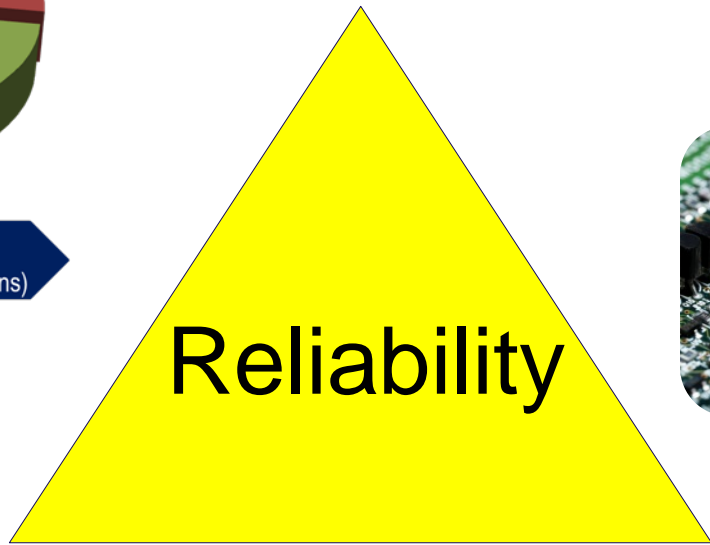4. Ongoing actions and way forward

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1. The FIDES method – reminder of what it is and why it is considered for Space applications

- FIDES is the most recently developed reliability prediction calculation method for electronic systems based on physics of failures (PoF), field return (mainly military & aeronautics) & tests.

- It has been introduced in 2004 by a consortium of French industrials (led by DGA & MBDA, including Thales, Eurocopter, Airbus, Nexter), with an update in 2009

- Support structure = FIDES working group meeting 4 times each year

- Also known as the UTE C80811 standard

- The standard is free of use, and a free tool (FIDES ExperTool) is available – downloadable at www.fides-reliability.org
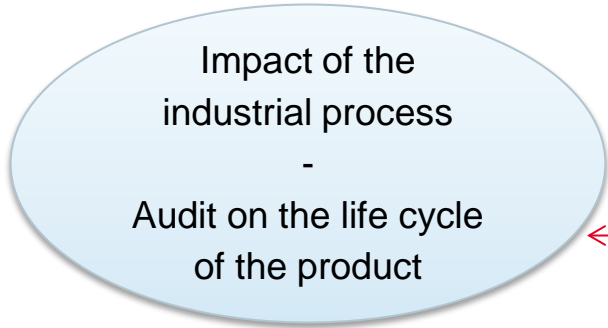
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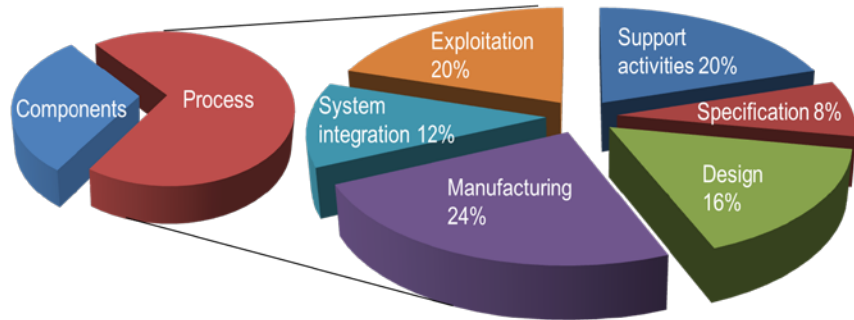
We could not neglect about 70% of the failure root causes : process has to be taken into account = Πprocess audit check list (#250 questions)

Technologies → Technological classification of components
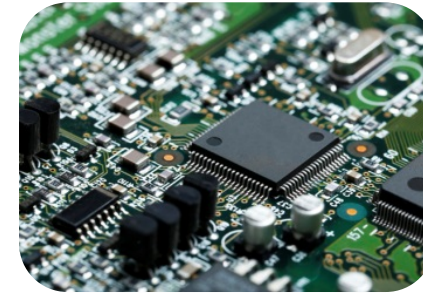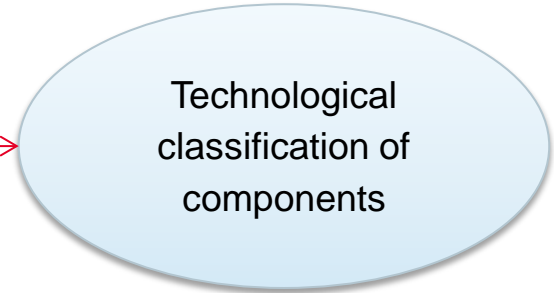
Reliability

Process ← Impact of the industrial process - Audit on the life cycle of the product
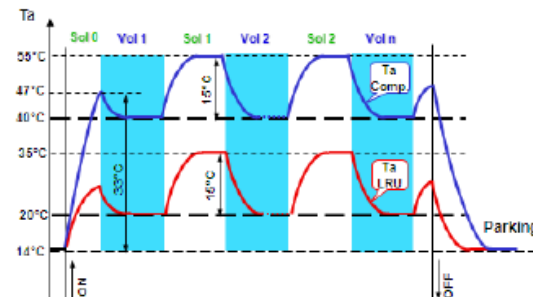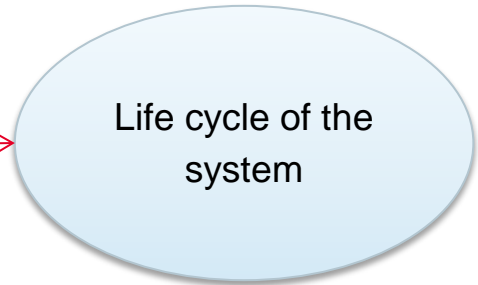
Use → Life cycle of the system

ESCCON 2019 – FIDES updates

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1. The FIDES method – reminder of what it is and why it is considered for Space applications

- The MIL HDBK, for a long time considered as the main EEE reliability method used in Space becomes obsolete (last update is 1995):
  - ➢ new components not modelled,
  - ➢ new generations of existing components not modelled either,
  - ➢ field return used dates from 1980-1990s.
- MIL HDBK computations do not take into account ON/OFF and thermal cyclings
- Quality levels as modelled through the MIL-HDBK-217 give pessimistic results for commercial parts in particular
- Data calculated through in orbit return (when possible) present much lower reliability values than with MIL, but results are in the same range when calculated with FIDES

	FR FIT MIL	FR FIT FIDES	FR In Orbit Return	Ratio MIL/IOR	Ratio FIDES/IOR
SCU (minus MRE)	1293.63	317	201.7	6.41	1.57

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1. The FIDES method – reminder of what it is and why it is considered for Space applications

- FIDES makes it possible "to quantify":

  - ✓ Impact of Life Profile on equipment reliability (Ambient Temperature, Thermal cyclings, Vibrations,…..):
    - ➔ **Life Profile**

  - ✓ Reliability impact of a component policy ➔ Quality and level of qualification of the part:
    - ➔ **Pi_Part_Manufacturing factor**

  - ✓ Impact of the company strategy in term of processes (development, manufacturing, support activities etc…):
    - ➔ **Pi_Process factor**

  - ✓ Design sensitivity to external factors (overstress, conditions of use, etc…):
    - ➔ **Pi_Induced factor**

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2. **Evolutions since 2016, current situation and perspectives for FIDES**

3. Updates on the position of ADS and the European space community vs FIDES

4. Ongoing actions and way forward

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2. Evolutions since 2016, current situation and perspectives for FIDES

2001
Beginning of the FIDES project

2004
FIDES 1st issue

2005
FIDES became a UTE standard

2007
Creation of the FIDES working group - Beginning of the FIDES 2 project

2009
FIDES 2nd issue

2010
PEA REX validation by military and aeronautics field return

2013
ExperTool free software

2015
Beginning of the PISTIS study

2018
Creation of a working group to make an IEC standard out of FIDES

2020
Scheduled 3rd issue of FIDES

NOW

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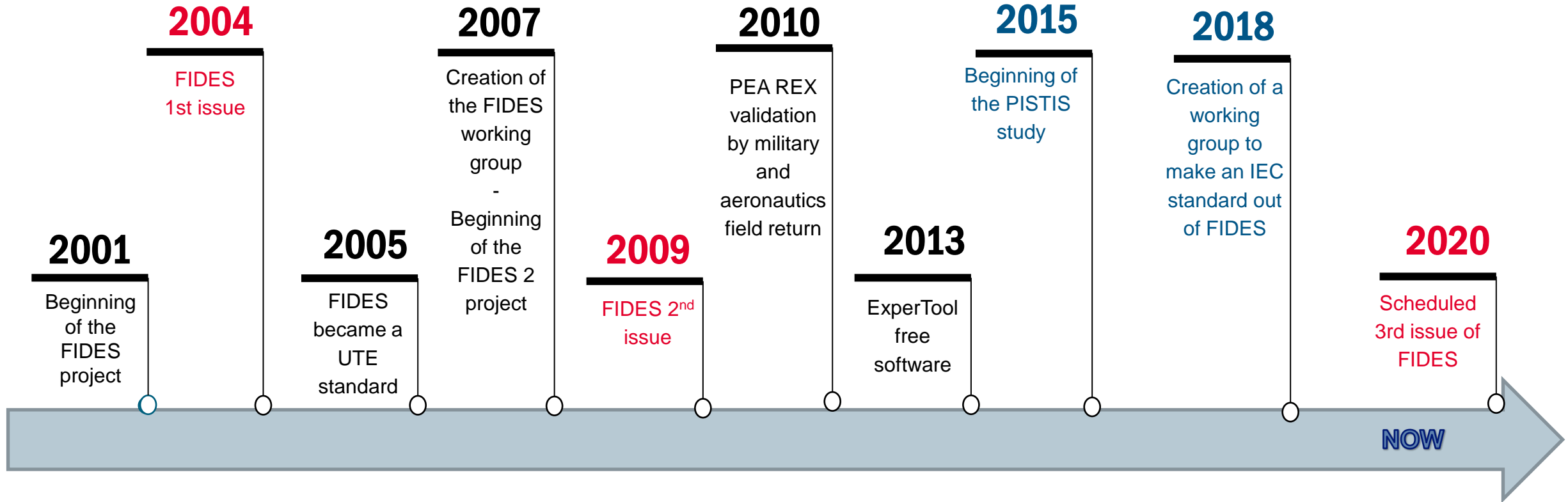
2. Evolutions since 2016, current situation and perspectives for FIDES

The PISTIS project (2015-2019)

- Collaborative study between 15 companies and academics with the DGA (French MoD)
- Several major updates ongoing to answer the following questions:

  - Reliability of DSM, RF-HF (GaN) and power (IGBT, MOSFET) components
  - FIDES existing models: are they adapted to these new technologies?
  - What about lifetime (wearout) of these technologies?

- With also FIDES models or parameters revision :
  - Base Lambdas die and case
  - Pi process Audit
  - Pi induced (EOS, MOS, TOS)

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2. Evolutions since 2016, current situation and perspectives for FIDES

The PISTIS project (2015-2019)

- WP1, 2 and 3: reliability tests

  WP1 – DSM :

  - ❖ NAND, NOR => tests started in Sept. 2017, 1st failures analyzed
  - ❖ FPGA: tests started in Jan. 2018
  - ❖ DDR3: tests started in Oct. 2018

  WP2 – MOSFET & IGBT :

  - ❖ Thermal cycling : started in Oct. 2018
  - ❖ Power Cycling, started in July 2018, 1st failures analyzed

  WP3 – GaN (+GaAs) :

  - ❖ Tests (DC & CW Comp.) on GaN, started in Q1 2017.
  - ❖ First results, slight trend to be confirmed.

WP1 – Component families	Technology node
FPGA **Xilinx**	28nm
Flash **Micron**	NAND MLC 20nm
Flash Spansion-**Cypress**	NOR 65nm
DDR3 **Micron**	25nm
DDR3 **Micron**	20nm

WP2 - Component families	Characteristics
IGBT, **Microsemi**	600V field stop
MOSFET, **Infineon**	N Chan., $V_{(BR)DSS}$ 200V
MOSFET, **STM**	N Chan., $V_{(BR)DSS}$ 650V

WP3 - Component families	Characteristics
GaN-HEMT GH25, **UMS**	15W, V_{DS}=30V
GaN-HEMT GL2D, **SEDI**	20W, V_{DS}=43.5V

2. Evolutions since 2016, current situation and perspectives for FIDES

The PISTIS project (2015-2019)

• WP4.1, Screening methods (ESS)

Done :

> ❖ State of the art and Capitalization of screening methodologies, from industrial partners.
>
> ❖ Guideline about screening methodologies, final validation by DGA

• WP4.2, Aggravated tests (HALT)

Done :

> ❖ State of the art and Capitalization of HALT methodologies, from industrial partners.
>
> ❖ Guideline about HALT methodology, final validation by DGA

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2. Evolutions since 2016, current situation and perspectives for FIDES

FIDES at IEC « A global methodology for reliability data prediction of electronic components »

- 2017 : acceptance of this new proposal by IEC
- 81% success on this vote (results table below)
- Normative standard under IEC-63142 reference on the way
- Standard scheduled for 2020

Approval				
P-Members Voting	P-Members Approving	Approval %	Criteria	Result
16	13	81.3	>= 66.7 %	Approved
Participation				
Number of P-Members	P-Members approving and participating	Criteria		Result
23	7	>=5		Approved

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2009 - ADS: FIDES 2004 audit performed Method applied for Carmat and Military projects

2015 - ADS: First use of the standard for satellites – OneWeb project

2016: RPDSM study for ESA
➔ Comparison of FIDES with MIL-HDBK

2017: Beginning of the **NRPM study for ESA** – FIDES used as baseline to model EEE parts

ESCCON 2019 – FIDES updates

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3. Updates on ADS and the European space community wrt FIDES

Airbus Defence and Space and FIDES

- Within Airbus Group, it has been used for years for Civil Aircrafts' processors and is currently being used on the Ariane 6 programme.

- Within Airbus Defence & Space, FIDES had been used for years on Defence programmes and specific projects, in agreement with the customer (ex: CARMAT, Artificial Heart)

- Within Airbus Defence & Space, FIDES has been used on Constellations programmes (ex: OneWeb, where it has been applied on almost all electronics units), and is highly recommended for all New Space programmes, to begin with.

- All entities (UK, Germany & France) within the RAMS department in Airbus Defence & Space work together in order to have the same approach for the application of FIDES, approach consistent with the upcoming New Reliability Prediction Methodology to be used in the future.

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3. Updates on ADS and the European space community wrt FIDES

The European space community and FIDES

- In 2015-2016, the Reliability Prediction Datasources for Space Modelling (RPDSM) study, performed by Airbus Defence & Space for ESA, provided both a quantitative and qualitative analysis of both MIL-HDBK-217F and FIDES for EEE predictive reliability calculations.

   Its conclusion was the recommendation to switch to FIDES for new projects, with foreseen necessary adaptations for the Space applications.

- Since 2017, ongoing study for ESA called New Reliability Prediction Methodology for Space Applications (NRPM) performed with MATRISK as the prime of a consortium with Airbus Defence and Space, Thales Alenia Space, SERMA technologies and SAREL.

   For the EEE components reliability calculations, the main method proposed is FIDES, with some guidance on how to apply it on Space applications.
   Conclusion of the study in 2020.

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3. Updates on ADS and the European space community wrt FIDES

IMdR - French Risk Management Institute – FIDES Working Group

Creation in 2017 of a subgroup for Space Applications

Objectives:
- Raise discussions/propositions on how to adapt FIDES to Space applications
- Propose / Define common approaches for the Space community

Topics already broached:
- Mission profiles and Pi Application
- Pi Part Manufacturing – Proposition for updates, validation & simplification
- Pi Process – Discussions on if and how the Audit could be simplified
- Components: Discussions around important contributors (ex: capacitors, RF parts…)

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- Conclusions of the PISTIS project expected for 2020, jointly with a new release of the guide

- The FIDES method will become an IEC standard in 2020 as well

- The Space subgroup of IMdR will go on addressing the main topics for the application to Space – anybody is welcome to join the discussions

- NRPM study conclusions in 2020

- Within Airbus Defence & Space, the objective is to propose FIDES for all new projects and to discuss /share with both our suppliers and customers to make the switch as easy and organic as possible

- Soon, the OneWeb constellation will be operating and will allow Airbus Defence & Space to compare reliability predictions for EEE units with In Orbit Return for the related mission profile.
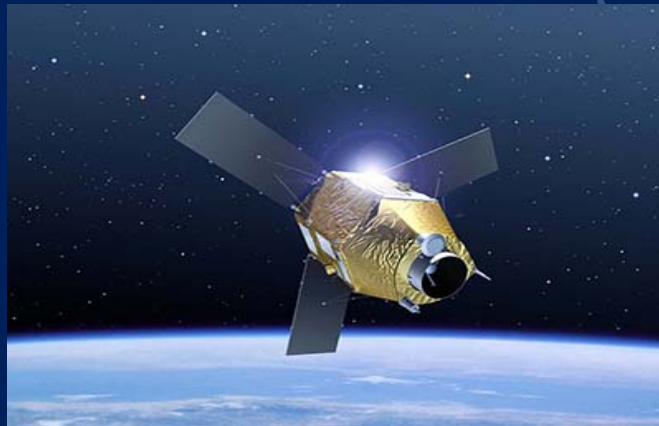
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Thank you

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