

Towards a Systems Engineering Framework Adapted to the NewSpace Industry

Mamadou Lamine Ndao, Claude Baron, Einar Knudsen, Kelson Joao

▶ To cite this version:

Mamadou Lamine Ndao, Claude Baron, Einar Knudsen, Kelson Joao. Towards a Systems Engineering Framework Adapted to the NewSpace Industry. ESA CubeSat Industry Day, Sep 2023, Leiden (Netherlands), Netherlands. 2023. hal-04573088

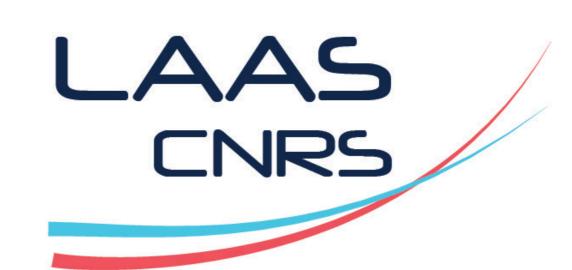
HAL Id: hal-04573088 https://laas.hal.science/hal-04573088

Submitted on 13 May 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Towards a Systems Engineering Framework Adapted to the NewSpace Industry





Mamadou Lamine Ndao^{1,2}

mamadou-lamine.ndao@expleogroup.com

Claude Baron²

Einar Knudsen¹

Kelson Joao¹

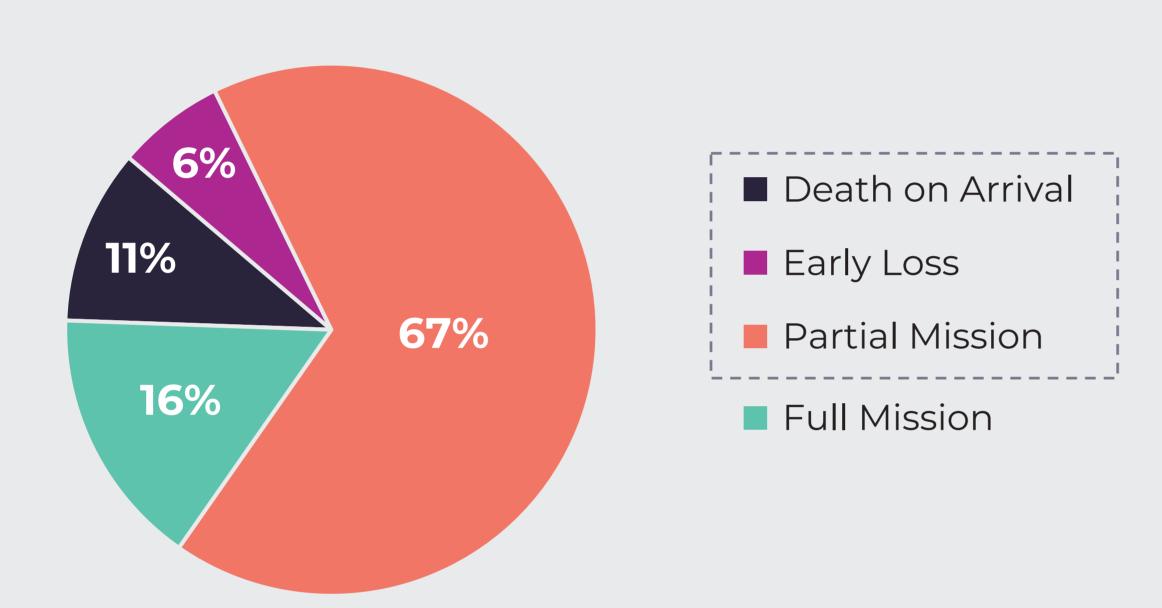
- Laboratory of system analysis and architecture, LAAS-CNRS, Toulouse, France
- 2) Expleo Group, Toulouse, France

ABSTRACT: The space sector is currently undergoing radical changes, with the emergence of CubeSats projects. However, among the numerous nanosatellites launched every year, only a few complete their missions. Faced with tight time-to-market and highly optimized budgets, without any reduction in project complexity, NewSpace companies do not usually have the means to apply the best systems engineering practices. Specifying systems engineering processes that would be adapted for nanosatellite projects would certainly enhance the success rate. The objective of this research is to study the application of systems engineering in the NewSpace sector and to propose a new systems engineering framework adapted to the industry.

[1], [2], [3]

High Number of CubeSat Mission failures

ALL MISSIONS REACHING ORBIT 2022-2023



Over 80% of CubeSats do not fully complete their mission [4]



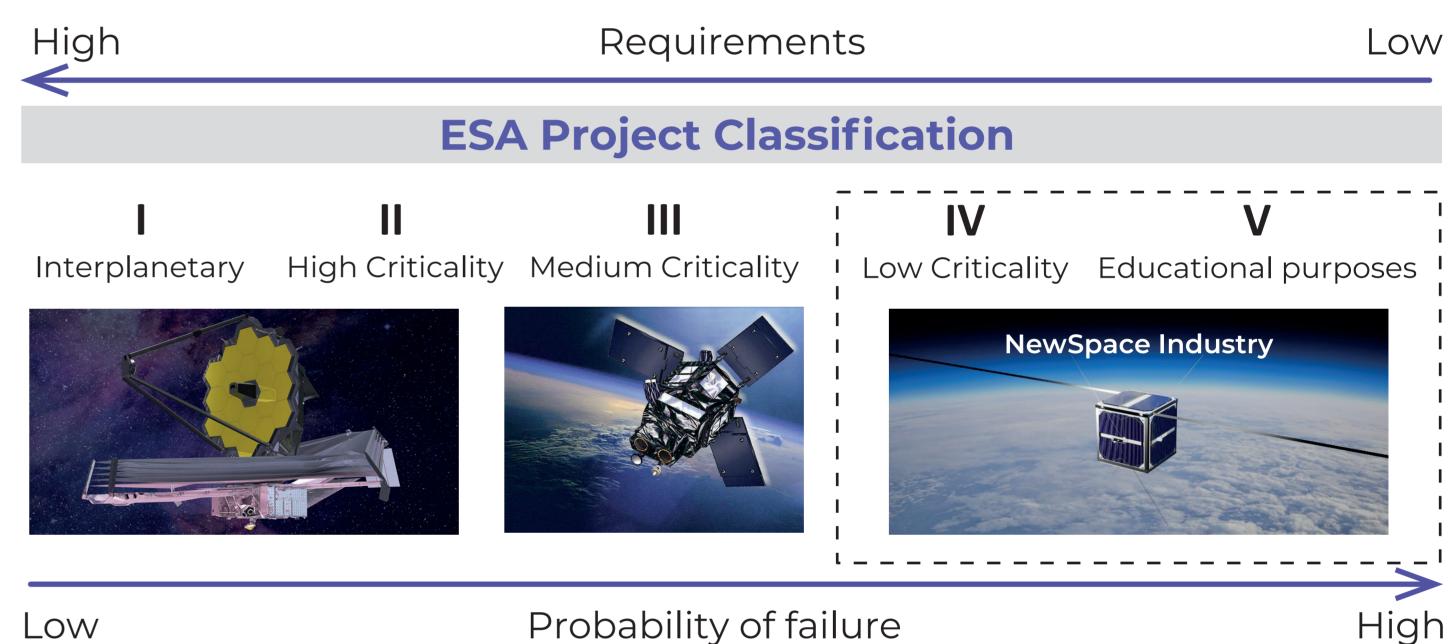
Our preliminary industry survey shows that systems engineering is applied but norms are not adapted

Lack of a Suitable Systems Engineering Framework for CubeSats

Norm/Standard	Advantages	Limits
ISO 15288	Comprehensive14 technical processes	Too complexRequires predisposed knowledge
ISO 29110	 Modular Easy to implement Appropriate for small teams Generic 	GenericLimits to complexityNo requirements
ECSS-E-ST-E-10	ComprehensiveLists requirements	ComplexNot a process

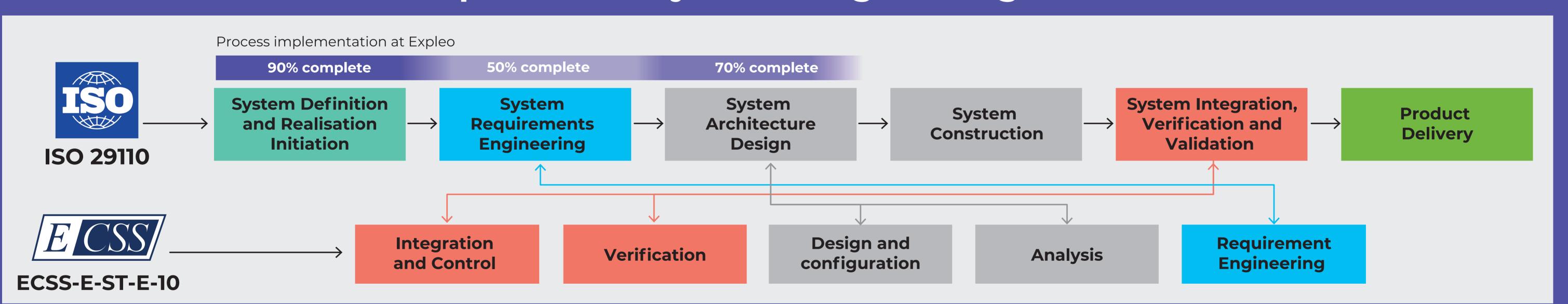
- Current norms are not adapted to the NewSpace Ecosystem
- Adapted to traditional timelines and budgets
- Too complex

Overlap between NewSpace and ESA class IV & V projects

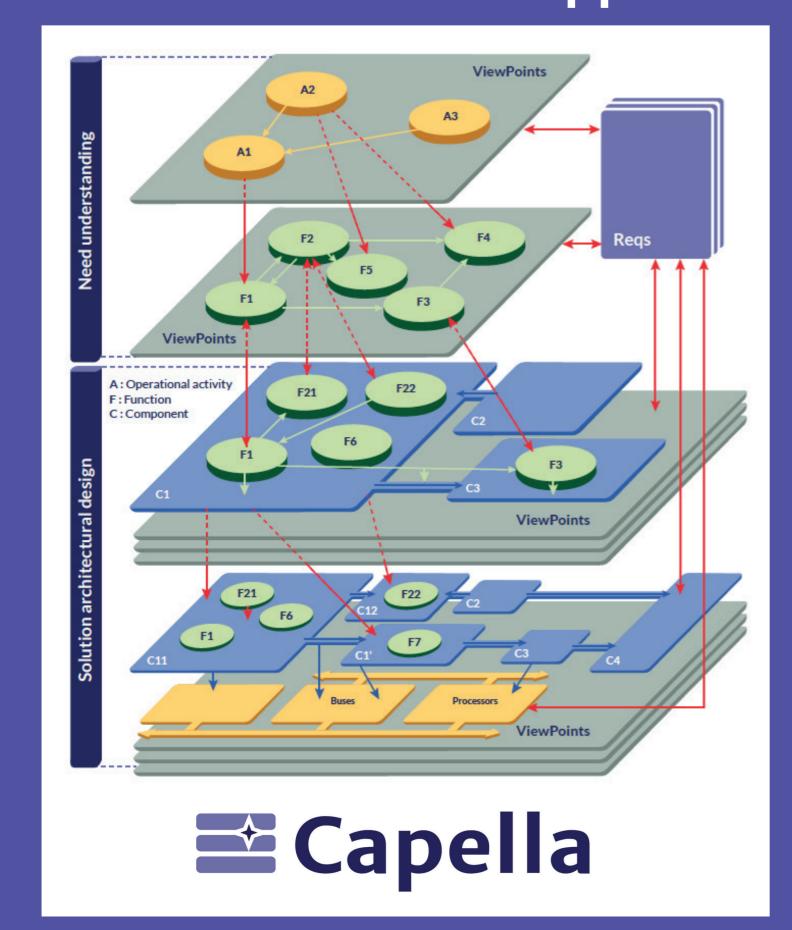


No systems engineering standards adapted for class IV and V projects

Our Proposal for a Systems Engineering Framework



Towards an MB4SE approach



Progress	Feedback	Limits
Deployed "on paper"	 Management is onboard The system engineering plan is based on the ISO 29110 Phases are defined Development framework is clear 	Compatibility with companyProcessesQuality systemCulture and traditional way of doingManagement
Accessibility	Easy to take into useAdaptable to our team's sizeFree	 Acceptance: team members are not used to working with System Engineering
Implementability	 Phases are clear "Space requirements" are implemented through the ECSS 	 Needs a system function Needs a quality function ECSS specific requirements are difficult to propagate through the team
Adaptability	 The 29110 responds well to coupling with the ECSS The 29110 overlaps with internal structures 	Sometimes difficult to identify overlap

References and further reading

[1] C. Cappelletti and S. Battistini, CubeSat Handbook: From Mission Design to Operations. Elsevier Science & Technology Books, 2020.
[2] I. Chechile, NewSpace Systems Engineering. Cham: Springer International Publishing, 2021. Consulted on 7 July 2023. [Online]. Available: https://doi.org/10.1007/978-3-030-66898-3
[3] E. Honoré-Livermore, "CubeSats in University: Using Systems Engineering Tools to Improve Reviews and Knowledge Management", Procedia Comput. Sci., vol. 153, p. 63–70, 2019.

Consulted on 5 July 2023. [Online]. Available: https://doi.org/10.1016/j.procs.2019.05.056