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Towards a Systems Engineering Framework Adapted to the NewSpace Industry



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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]

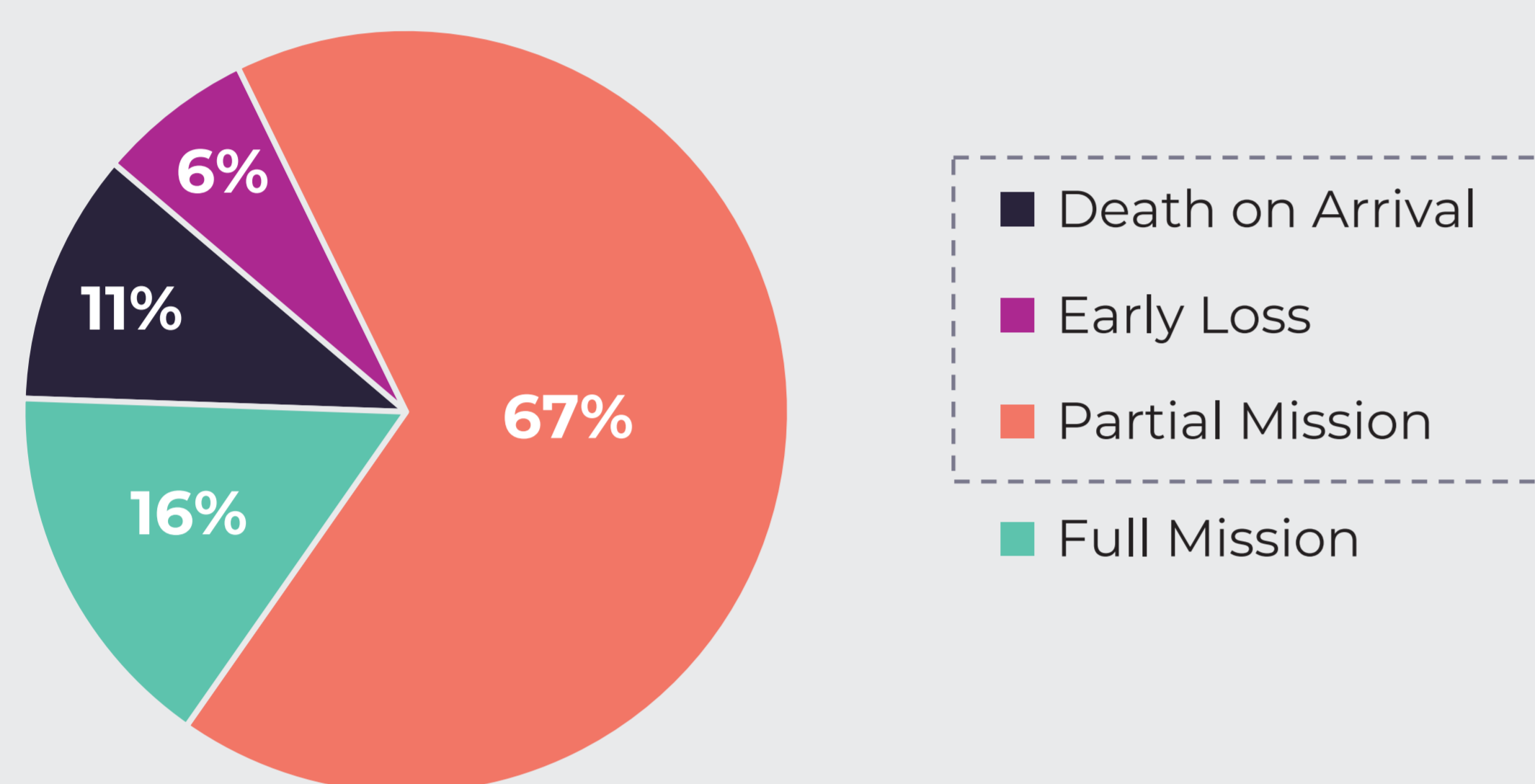
Lack of a Suitable Systems Engineering Framework for CubeSats

Norm/Standard	Advantages	Limits
ISO 15288	<ul style="list-style-type: none"> Comprehensive 14 technical processes 	<ul style="list-style-type: none"> Too complex Requires predisposed knowledge
ISO 29110	<ul style="list-style-type: none"> Modular Easy to implement Appropriate for small teams Generic 	<ul style="list-style-type: none"> Generic Limits to complexity No requirements
ECSS-E-ST-E-10	<ul style="list-style-type: none"> Comprehensive Lists requirements 	<ul style="list-style-type: none"> Complex Not a process

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

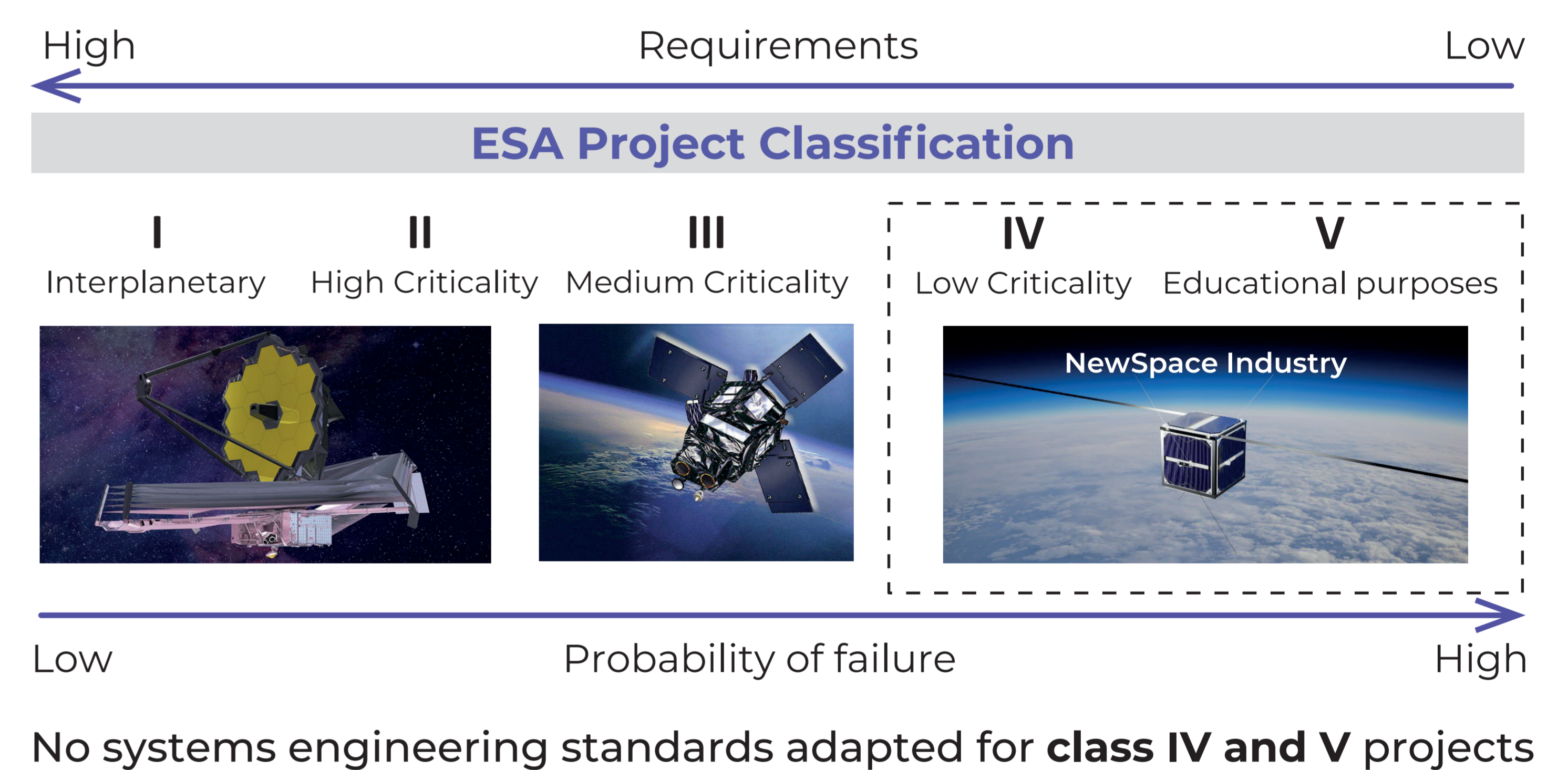
High Number of CubeSat Mission failures

ALL MISSIONS REACHING ORBIT 2022-2023



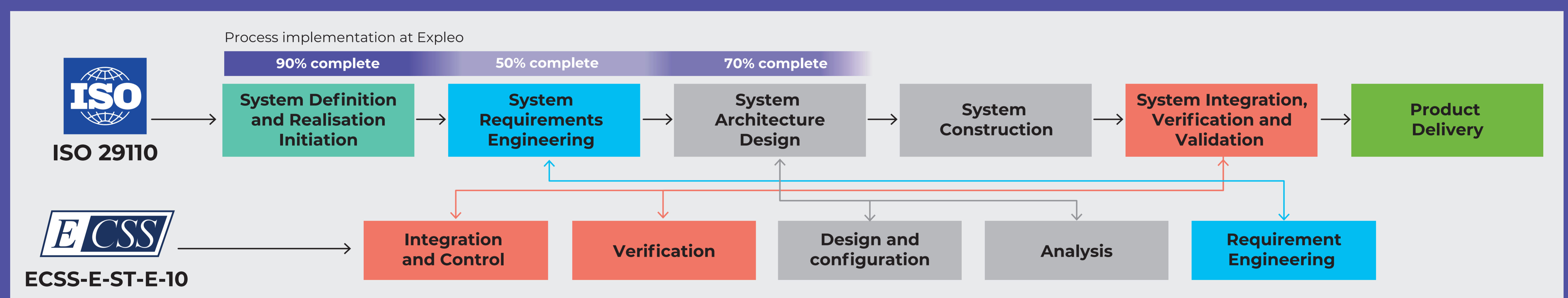
Over 80% of CubeSats do not fully complete their mission [4]

Overlap between NewSpace and ESA class IV & V projects

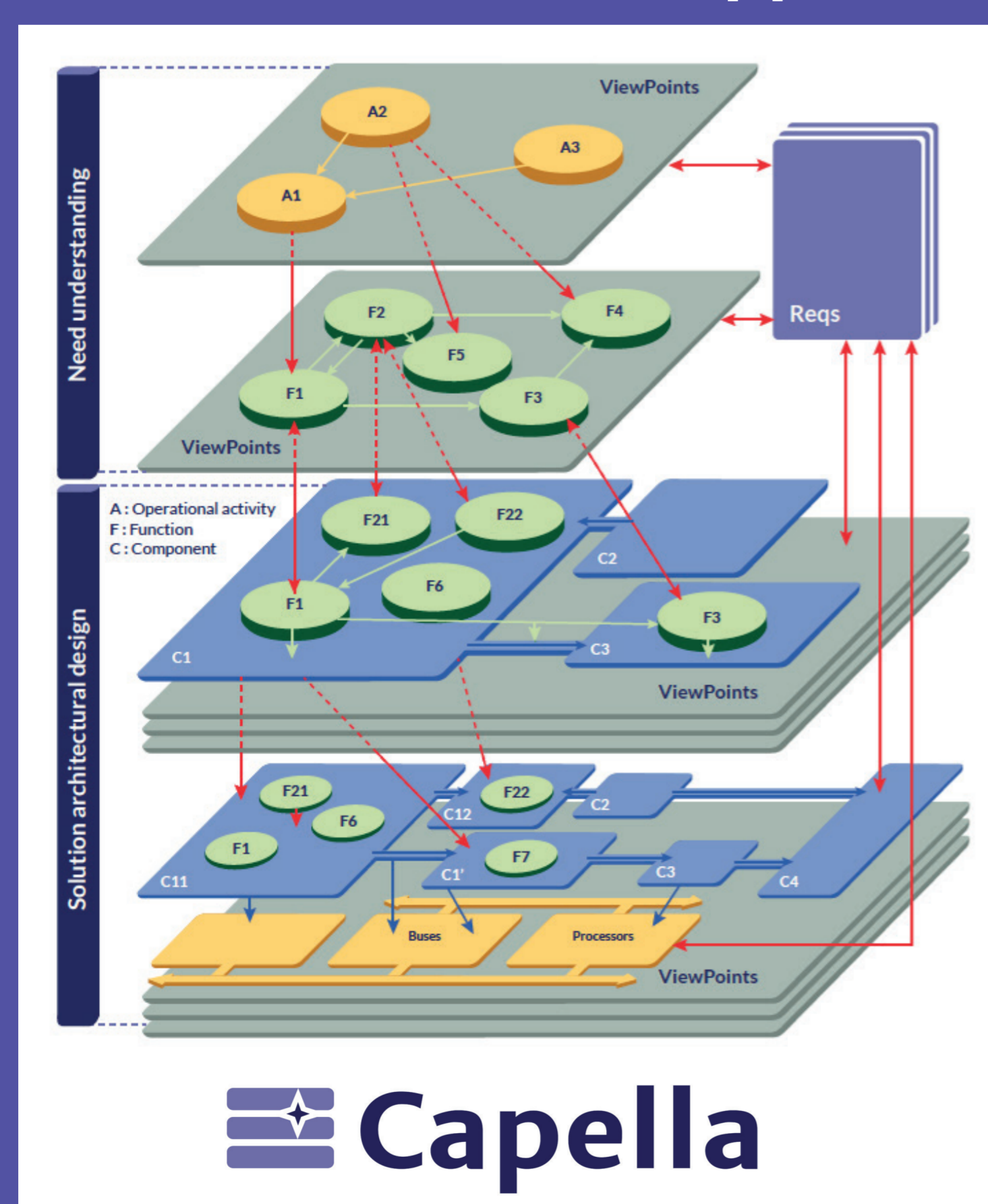


! Our preliminary industry survey shows that systems engineering is applied but norms are not adapted !

Our Proposal for a Systems Engineering Framework



Towards an MB4SE approach



Progress	Feedback	Limits
Deployed "on paper"	<ul style="list-style-type: none"> Management is onboard The system engineering plan is based on the ISO 29110 Phases are defined Development framework is clear 	<ul style="list-style-type: none"> Compatibility with company Processes Quality system Culture and traditional way of doing Management
Accessibility	<ul style="list-style-type: none"> Easy to take into use Adaptable to our team's size Free 	<ul style="list-style-type: none"> Acceptance: team members are not used to working with System Engineering
Implementability	<ul style="list-style-type: none"> Phases are clear "Space requirements" are implemented through the ECSS 	<ul style="list-style-type: none"> Needs a system function Needs a quality function ECSS specific requirements are difficult to propagate through the team
Adaptability	<ul style="list-style-type: none"> The 29110 responds well to coupling with the ECSS The 29110 overlaps with internal structures 	<ul style="list-style-type: none"> Sometimes difficult to identify overlap

References and further reading

- [1] C. Cappellotti 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-Livemore, "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>
[4] CubeSat Sensus, M.Swartwout, using SLU Seradata Augmented Data. URL: <https://sites.google.com/a/slu.edu/swartwout/home?authuser=0>, data extracted on 21/07/2023.