

MECHANICAL ENGINEERING

MUR DM 117/Thales Alenia Space - Digital Twin for Space Products: Methodology, Approaches and Application to In-Orbit Servicing

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Context of the research activity	<p>This PhD proposal aims to develop a Digital Twin framework tailored for space products, focusing on in-orbit servicing (IOS) applications. The project encompasses defining Digital Twin requirements, adapting it to Thales Alenia Space Italia's needs, building an IOS demonstrator, and evaluating its technical and operational aspects with end users. The ultimate goal is to create a roadmap for its continued evolution.</p> <p>Progetto finanziato nell'ambito del PNRR - DM 117/2023 - CUP E14D23002030004</p>
	<p>Context:</p> <p>The rapid advancement of space technology has opened new frontiers in satellite development, resulting in increasingly complex and expensive missions. Ensuring the reliability and longevity of space products is critical, especially for missions with extended lifetimes and those targeted for in-orbit servicing (IOS). Thales Alenia Space Italia, a leading aerospace company, is at the forefront of these developments. To address these challenges, this PhD project proposes the development of a Digital Twin framework for space products, with a specific focus on IOS applications.</p> <p>Main Objectives:</p> <ol style="list-style-type: none">1. Digital Twin Definition and State-of-the-Art Review: The project will start with a comprehensive review of the existing literature and industry practices related to Digital Twins in the context of space engineering. This phase aims to define precisely what a Digital Twin is and establish a clear understanding of the state-of-the-art technologies and methodologies.

Objectives

2. Minimum Requirements for Space Engineering Digital Twins: This phase will identify the minimum requirements that a Digital Twin must fulfill to be applicable to space engineering and servicing contexts. This involves considering factors like data accuracy, real-time capabilities, and integration with existing space systems.

3. Methodology Development: Building upon the insights gained from the literature and the specific needs of Thales Alenia Space Italia, a methodology for developing and maintaining Digital Twins for space products will be devised. This methodology will encompass data acquisition, modeling techniques, and validation processes.

4. Tailoring the Digital Twin for IOS at DESI: The project will focus on tailoring the Digital Twin framework to the specific requirements of the Torino facility's Dominio Esplorazione e Scienza (DESI) division, with a particular emphasis on IOS applications. This includes adapting the framework to the DESI environment and considering the unique challenges of servicing missions.

5. Demonstrator Development: A practical demonstrator of the Digital Twin framework will be developed. This will involve developing a prototype Digital Twin for IOS applications. The demonstrator will serve as a testbed for the methodology and a valuable tool for staff training.

6. Technical and Operational Evaluation: The PhD candidate will work closely with end users, including space engineers and IOS specialists, to evaluate the technical and operational aspects of the Digital Twin in a real-world environment. This phase aims to identify strengths, weaknesses, and areas for improvement.

7. Roadmap for Evolution: Based on the feedback and insights gained from the demonstrator and operational evaluation, a roadmap for the continued evolution of the Digital Twin framework will be developed. This roadmap will outline future research directions and improvements to ensure its long-term relevance and effectiveness.

Research Activities:

- Literature Review: Conduct a thorough review of existing literature and industry practices related to Digital Twins and space engineering.
- Requirements Analysis: Identify the minimum requirements for Digital Twins in space engineering, considering factors like data accuracy, real-time capabilities, and integration.
- Methodology Development: Devise a methodology for creating and maintaining Digital Twins for space products, including data acquisition, modeling techniques, and validation processes.
- Tailoring to DESI's Needs: Customize the Digital Twin framework to meet the specific needs of Thales Alenia Space Italia's DESI division, with a focus on IOS applications.
- Demonstrator Construction: Develop a practical demonstrator of the Digital Twin framework, implementing it in an IOS context.
- Evaluation and Feedback: Collaborate with end users to evaluate the technical and operational aspects of the Digital Twin, gathering feedback for improvement.
- Roadmap Development: Create a roadmap for the ongoing evolution of the Digital Twin framework, outlining future research directions and enhancements.

Expected Outcomes:

This research project will result in a well-defined Digital Twin framework tailored for space engineering, with a particular emphasis on in-orbit servicing applications. The deliverables will include a methodology, a practical demonstrator, and a roadmap for future development. These outcomes will

enable Thales Alenia Space Italia to enhance the reliability and efficiency of space products, especially those designed for extended missions and servicing, ultimately contributing to the advancement of space technology.

Skills and competencies for the development of the activity

The ideal candidate should possess a strong background in aerospace engineering, digital twin technologies, and space systems. Proficiency in data analysis, modeling, and a collaborative mindset to work closely with industry experts is essential. Strong communication and problem-solving skills are also crucial.