

Space Cost Engineering Conference ~SCE2024

Toulouse, France 3-4 October 2024 CNES



CONFERENCE REPORT prepared for the ESA Controlling Community

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Cost Engineering team, October 4th, 2024

Introduction

The fourth Cost Engineering Conference took place on October 3rd and 4th in Toulouse, with CNES (Centre National d'Études Spatiales) chairing the event, following the previous chairmanship of the Netherlands. The conference aimed to foster the exchange of best practices, methods, trends, and lessons learned within the cost engineering community. It provided a platform for participants to present and share their work on various topics such as design-to-cost, cost modelling, cost data acquisition, and affordability analyses.

Nearly 90 attendees participated, representing a diverse range of organisations including space agencies, EU institutions, universities, and industry players, from large space integrators to small and medium enterprises, as well as start-up companies.

The event was chaired by Mr. Frederic Moll, who leads Preliminary Projects Cost Evaluation at CNES, and co-chaired by Mr. Jean-Noel Bricout, the Deputy Director for Orbital Systems and Applications at CNES. The conference facilitated valuable discussions on improving cost estimation and management practices in space missions, further advancing the field of cost engineering in space exploration and technology development.

The full Conference programme & presentations are available on the event website, main page all the way down: [Space Cost Engineering Conference 2024 - 3 to 4 October 2024 at Toulouse, FRANCE](#)

This report provides an overview of each presentation. Click to view:

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Proceedings

Opening session

The opening session, led by Mr. Frederic Moll (CNES) and Michel van Pelt, Head of ESA's Cost Engineering Section, centred on the day's Space Cost Engineering agenda. They reflected on past conferences, workshops, and recruitment initiatives launched following the cost engineering conference two years ago at ESA/ESTEC. A key focus was the involvement of Cost Engineers in the ESA Academy Concurrent Engineering Workshops, which introduces space engineering students to cost engineering through design study exercises of one week, complementing current efforts to attract talent, such as internships, the ESA Young Graduate Trainee program, and more. The session concluded with a tribute to Mr. D. Shermon, who passed away earlier this year. He was QinetiQ Senior fellow and co-author and contributor of numerous books on [Cost engineering, Project control and Project management](#).



Mr. Frederic Moll (CNES) and Michel van Pelt (ESA) during their presentation



f Mr. Michel van Pelt (ESA) during his presentation

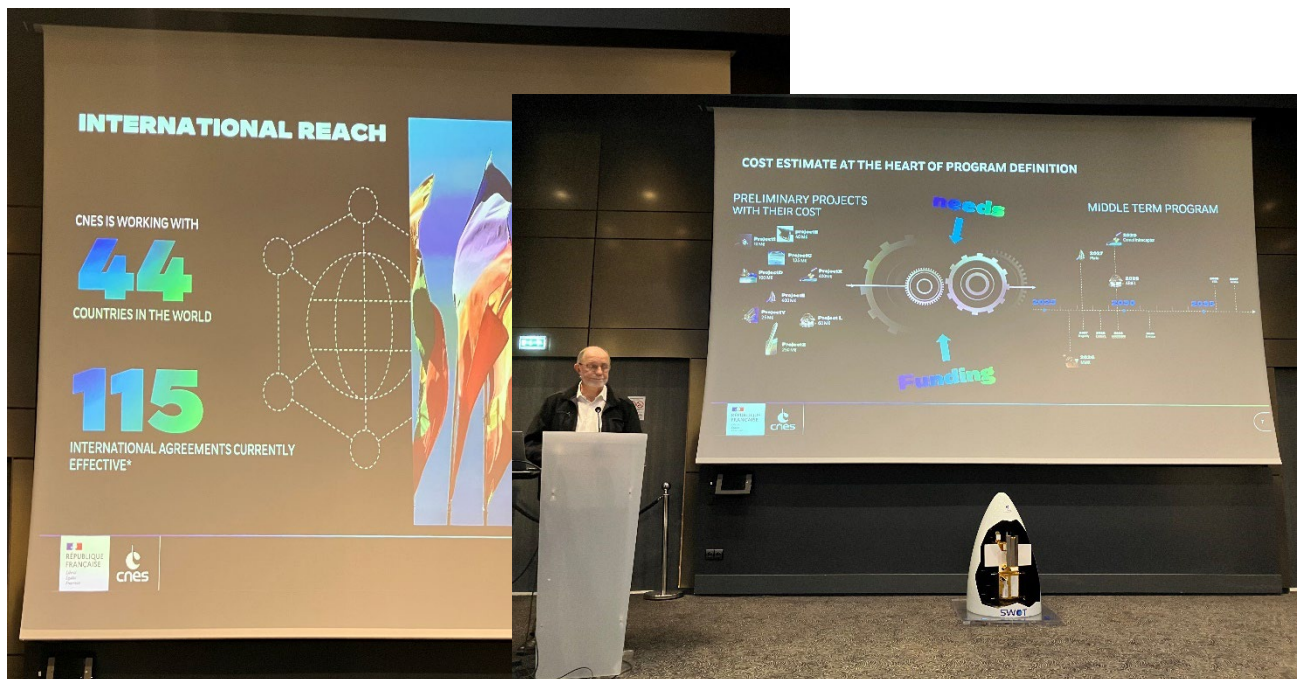


Mr. Shermon (QinetiQ fellow) during his presentation,
Last September 2022 at ESTEC

Session 1 – Welcome by CNES

Mr. Jean-Noel Bricout, Deputy Director for Orbital Systems and Applications at CNES,

Mr. Bricout provided an overview of CNES's structure, strategic priorities, and contributions to European and global space efforts. CNES operates primarily from Paris and Toulouse, employing approximately 2,300 people, with a focus on strengthening Europe's strategic independence in space. One of the key priorities is enhancing Europe's launch capabilities, particularly through operations from French Guiana, to support European missions. Additionally, CNES is deeply involved in defence projects, including Earth observation initiatives, contributing to national and European security.



Mr. Jean Noel Bricout during his presentation

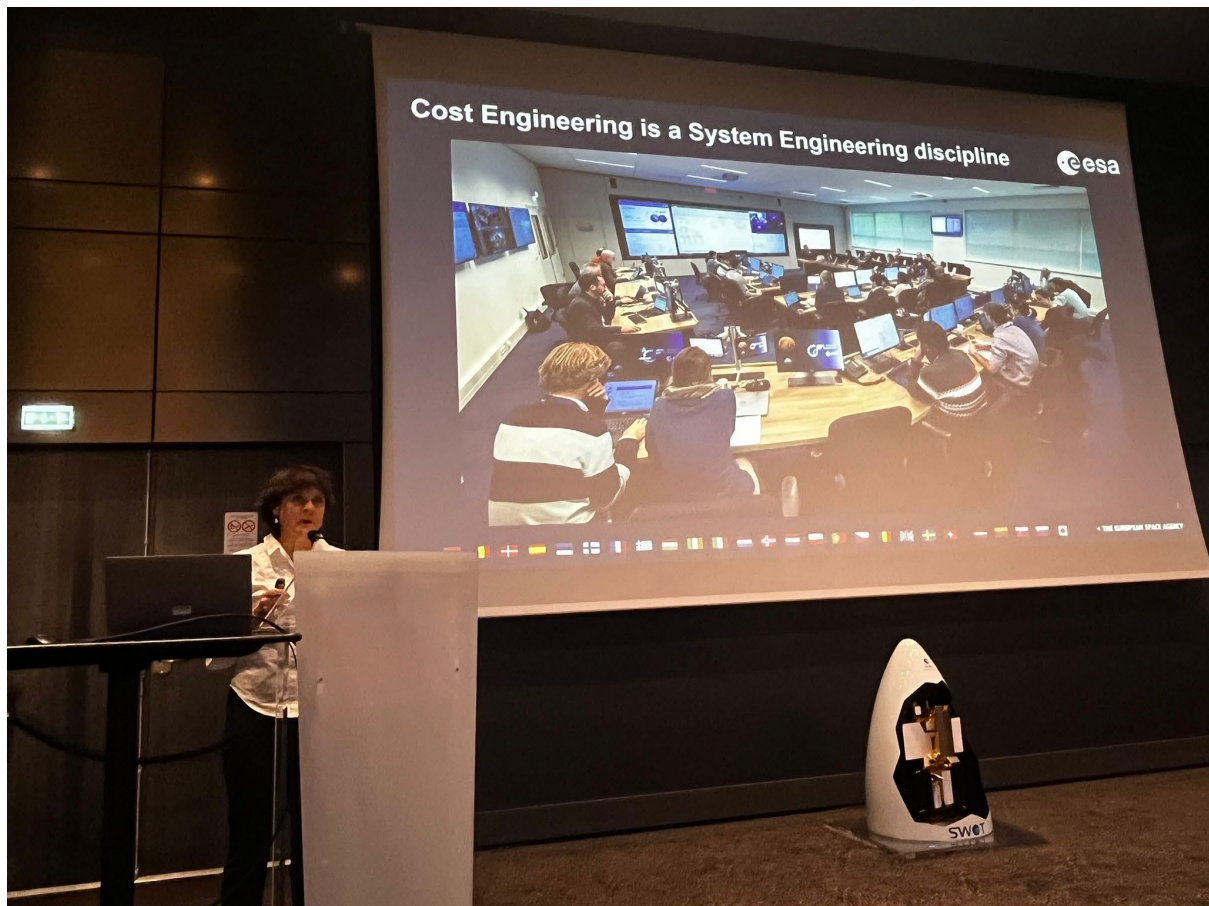
CNES also promotes competitiveness within the European space sector by supporting emerging "new space" companies, fostering innovation and encouraging growth. CNES is dedicated to sustainability and scientific excellence, with missions addressing climate change and ocean studies in partnership with other space agencies such as ESA, NASA, and JAXA. The French space sector encompasses around 70,000 individuals across industry, academia, and defence, and CNES emphasizes the importance of developing new skills to meet the future demands of space activities.

International collaboration is a key aspect of CNES's work, as it maintains partnerships with 44 countries, with particularly strong ties to NASA. These relationships facilitate numerous joint missions and research projects. CNES is funded by the French state, defence contracts, and contributions from ESA, supporting scientific research, telecommunications, and infrastructure development. The agency also emphasizes cost engineering in space project

development, recognizing the challenges of accurately estimating and managing budgets for complex space missions. Overall, CNES is committed to advancing France's leadership in space, promoting sustainability, and fostering international cooperation within the space sector.

Session 2 - Welcome by ESA

The speaker was Mrs. Agnes Mestreau, H/Systems Engineering Division at ESA.



Mrs. Agnes Mestreau during her presentation

- Agnes provided a presentation covering several key topics: The Role of Cost Engineering in System Engineering: Agnes emphasized how cost engineering is integrated into the system engineering framework, particularly within ESA's Concurrent Design Facility (CDF). She explained that cost is as critical as other engineering aspects, such as structure and telecommunications, from the mission's earliest stages.
- Design-to-Cost Approach: She highlighted the design-to-cost strategy, where cost considerations are built into the engineering design itself. This involves making trade-offs between cost, schedule, and risk to meet project goals without compromising technical requirements.
- New Space and Technological Advancements: Agnes addressed the shift in the aerospace industry, commonly referred to as "New Space," with its emphasis on cost-efficient, high-speed production cycles, such as the deployment of mega-constellations (e.g., launching one satellite per month). She also touched on the

emergence of reusable technologies and new service-based procurement models, especially in human spaceflight and LEO cargo return services.

- **Emerging Tools and Methods:** She discussed the adoption of advanced technologies like data mining and AI, which enhance cost estimation and decision-making. Additionally, she mentioned innovations like AI-enhanced telecommunications, 3D printing for component manufacturing, and how these tools are being integrated into projects for greater efficiency.
- **Adapting Cost Engineering Methods to Market Needs:** Agnes noted that cost engineering now adapts to both market shifts and new methodologies, enabling agile responses to the evolving demands of space missions and technology development.

Session 3 - Planning the AIV phase for an Extremely Large Telescope

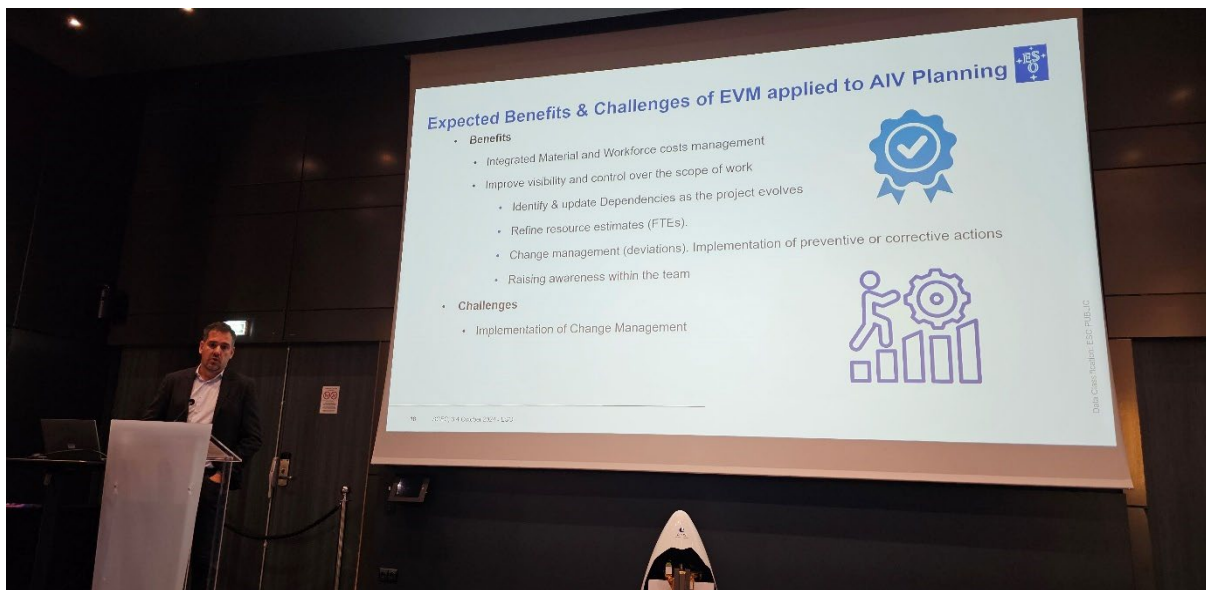
The speaker was Andrew Wright and I. López at ESO

Andrew Wright provided insights into the European Southern Observatory (ESO), emphasizing its matrix organizational structure, which allows multiple projects to be planned concurrently but often leads to limited visibility due to planning not being centralised in a single system.

To enhance visibility and efficiency for the ELT project within ESO, Andrew and Programme Control team adopted a bottom-up approach. This involved engaging technical engineers to estimate task durations and identify the necessary resources, including both personnel and facilities. They developed a database to support this methodology, which helps assess feasibility of timelines, available margins and program duration.

This structured feedback loop facilitates communication between project managers and technical teams, allowing for timely discussions and adjustments to mitigate discrepancies.

Understanding resource availability is critical for informed planning adjustments. As project needs change, the team can assess personnel / facilities availability and make necessary scheduling changes, ensuring alignment between timelines and resources.



Picture of Mr. I Lopez during his presentation

Additionally, they implemented Earned Value Management (EVM), using established Key Performance Indicators (KPIs) to provide continuous feedback on project performance and resource utilization.

Session 4 – Some attempts at cost estimation of SpaceX's Starship

The speaker was Mr. Sang-Hyeon Choi (Korea Aerospace Research Institute), Jascha Wilken, Martin Sippel (German Aerospace Center)

Sang-Hyeon Choi 's presented his work conducted while in DLR focused on cost estimation for SpaceX's Starship project, stressing the importance of early cost estimates for team sizing, affordability studies, and project feasibility assessments—especially during the Request for Proposal (RF) phase, when major costs are typically fixed.

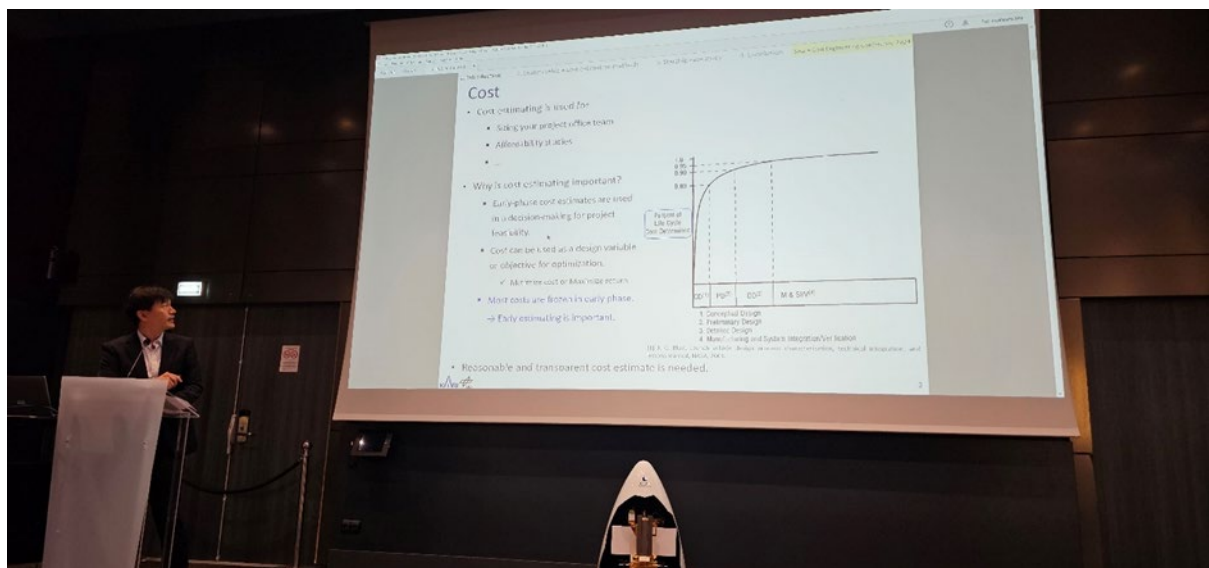
Starship Context and Findings:

- Starship's design is based on SpaceX's Interplanetary Transport System (ITS) concepts, with a strong emphasis on reusability and frequent flights to help reduce costs.
- Due to the lack of detailed public cost data from Elon Musk, the speaker relied on several cost estimation models to build a comprehensive cost analysis, factoring in flight frequency and reusability as key cost drivers.

Cost Estimation Tools Used:

By combining PCEC (NASA), Transcost, and Solstice, the speaker provided a nuanced cost analysis of Starship. These tools helped highlight how reusability and flight frequency impact

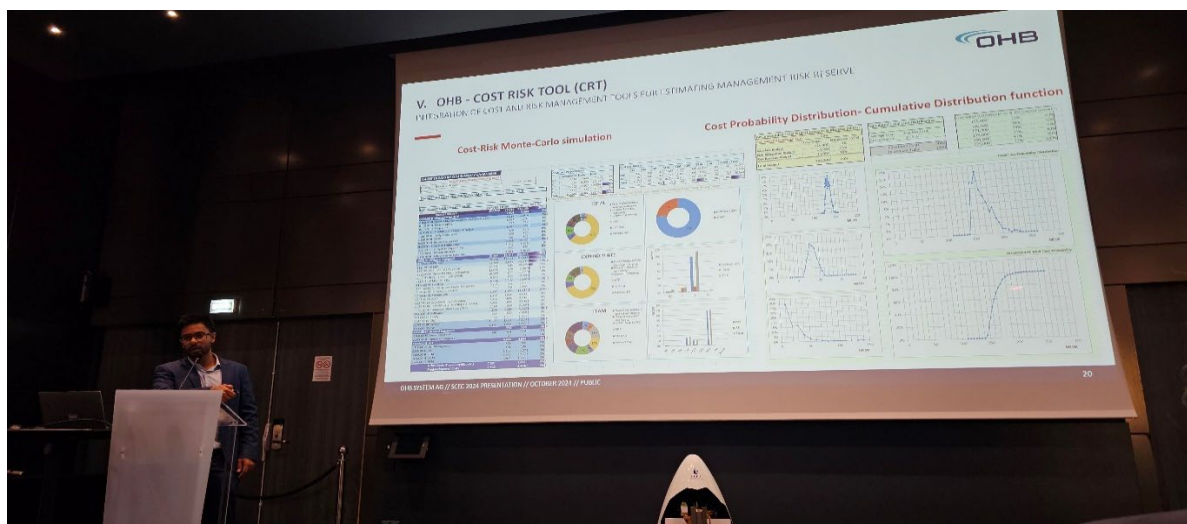
both manufacturing costs and operating costs. This enabled more informed decisions on budgeting, feasibility, and resource allocation, ultimately contributing to a better understanding of Starship's financial viability.



Mr. Sang-Hyeon Choi during his presentation

Session 5 - Leveraging Cost Engineering Processes and iterative cost estimation methods with an ecosystem of internally designed cost engineering tools

The speaker was Mr. Vedant Paul Mogha cost analysis department at OHB systems.



Mr. Vedant Paul Mogha during his presentation

The speaker discussed OHB System's cost engineering framework, emphasizing its role in managing costs throughout space project development. The framework consolidates data

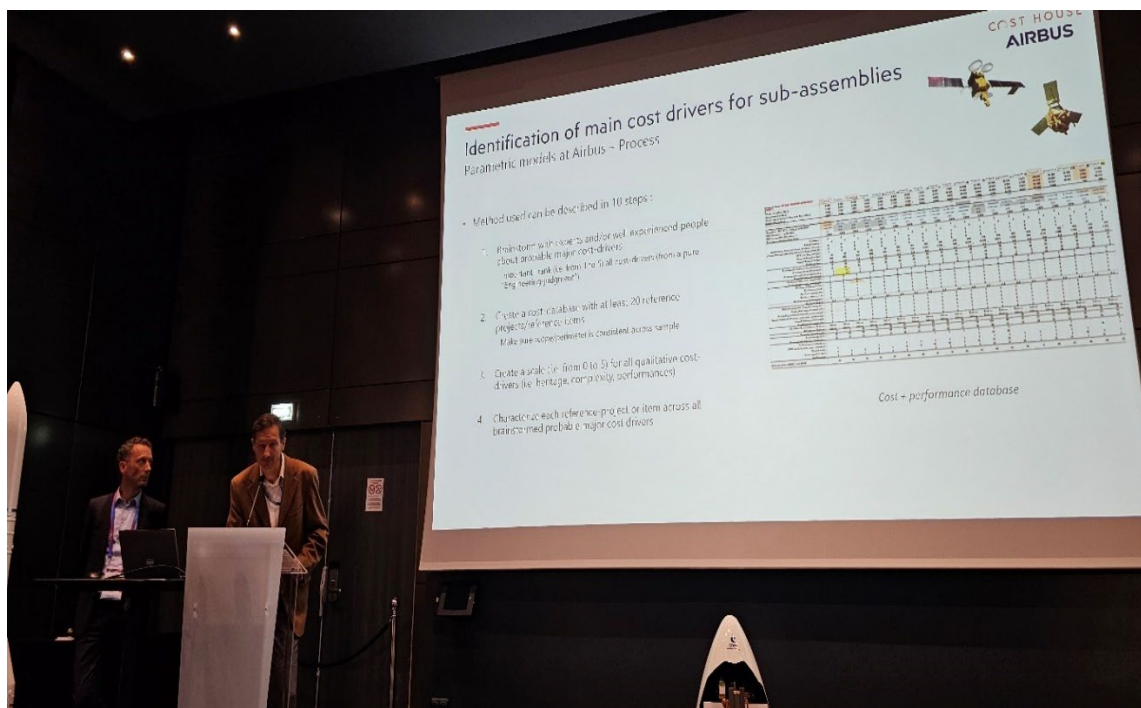
into a single source of truth, maintained across different project phases. It focuses on Design-to-Value & Design-to-Cost, ensuring project costs align with value objectives while staying within budget. Risk mitigation is a key focus, proactively managing risks to reduce cost overruns. Cost engineering and iterative design align costs with project goals, enhancing execution and supporting risk strategies. Unified cost management ensures consistency and accuracy, improving project outcomes. The integration of tools like the Cost-Risk Tool (CRT) and Baseline Cost Tool (BCT) helps manage uncertainties and strengthen cost control.

Session 6 – Implementing Design To Cost activities on a satellite

The speakers were Mr. Igor Le Pivert (Cost House – Partner) and Eric Van Landuyt (Airbus – Cost Estimator department)

Mr. Le Pivert discussed the challenges of renewing telecommunications satellites in a competitive market, emphasizing the increasing competition from new and ground-based systems. He highlighted the importance of establishing initial cost estimates for decision-making but pointed out the significant discrepancies in estimates from various sources. This disparity emphasises the need for better collaboration with suppliers and improvements in internal costing tools.

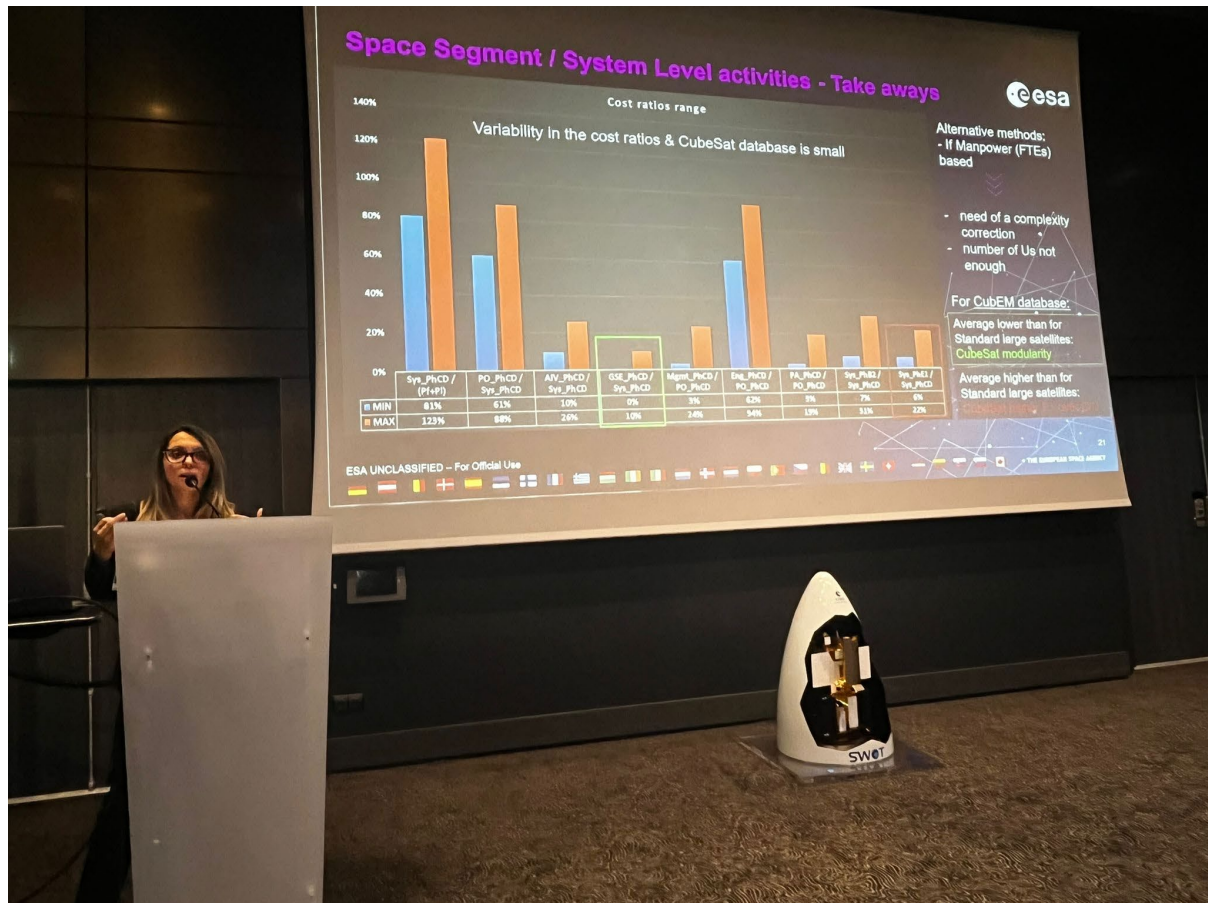
Mr. Le Pivert then introduced Eric Van Landuyt, a cost estimator at Airbus, who explains how, with seven years of experience, he develops parametric cost models for satellite projects. Eric's team uses data from past projects and expert collaboration, along with advanced software, to create accurate cost models. These models are continually refined and updated based on feedback to maintain their relevance and precision.



Mr. Igor le Pivert on the right and Eric Van Landuyt on the left during their presentation

Session 7 - Multivariate Modelling for End-to-End Cost Estimates in financially sustainable CubeSat Projects: the CubEM Approach

The speakers were Mrs. Giulia Cambone (Cost engineer – YGT at ESA) and Elisabetta Lamboglia (Cost engineer at ESA)



Mrs. Giulia Cambone during her presentation

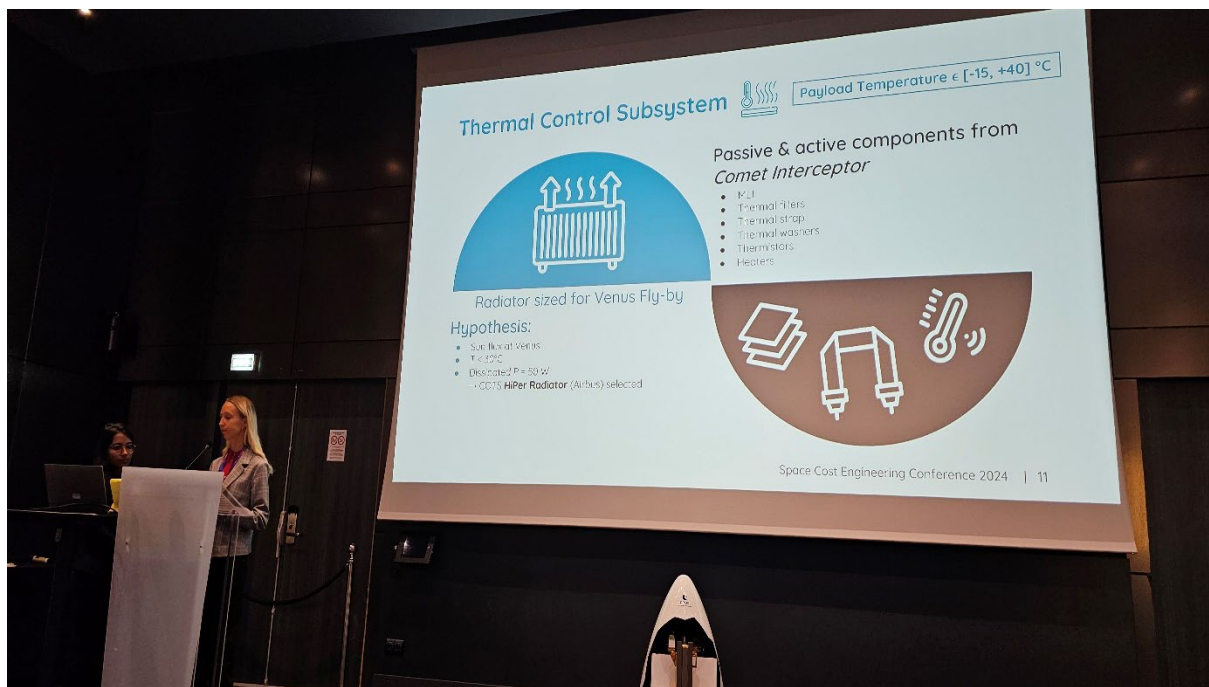
Mrs. Cambone presented the CubEM cost estimation approach, which is designed for early-stage space missions. The model aims to assist in project trades and identify cost drivers across various segments, including launch and ground operations. The key methodologies discussed included cost estimating relationships (CRS), which utilize mathematical functions to express costs based on multiple drivers, and an approach for estimating production and development costs.

The presentation highlighted the importance of data collection and analysis for accurate cost estimation, emphasising the need for a robust database that includes commercial off-the-shelf components. Future work will involve expanding the database and validating cost relationships to enhance the model's accuracy. The speaker also noted the challenges of applying the model to CubeSats due to their unique characteristics and the variability in cost ratios compared to standard satellites. Overall, the CubEM is positioned as a valuable tool for estimating costs in the evolving landscape of space missions.

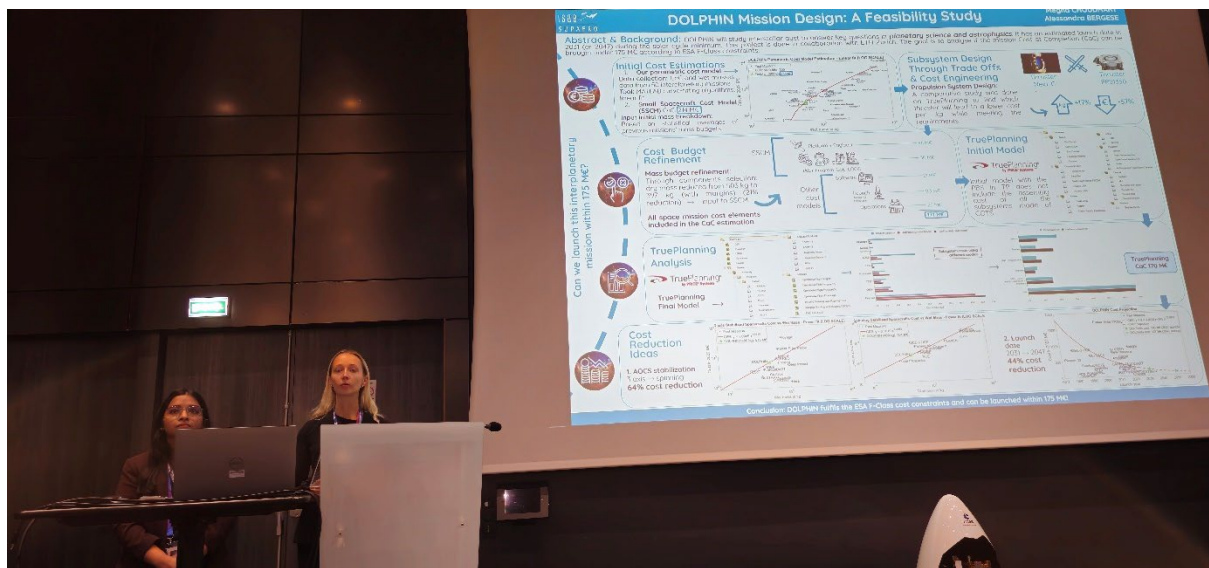
Session 8 – Optimising the DOLPHIN mission: A Feasibility Study using Cost Engineering Principles

The speakers were Mrs. Megha Choudhary and Alessandra Bergese, Master in Aerospace Engineering students.

The meeting focused on the Dolphin mission, a proposed space project aimed at studying interstellar dust and particles. The presentation outlined the mission's objectives, including a feasibility study to optimise costs and mass within the constraints set by the European Space Agency (ESA). The team, composed of Master in Aerospace Engineering students, discussed their year-long research under the guidance of their supervisors. Key points included the selection of subsystems, such as solar arrays and batteries, and the use of cost engineering principles to redefine the mission's budget, which was initially projected to exceed the ESA cap of 175 million euros. The students presented their analysis of past interplanetary missions to inform their cost estimations and proposed various strategies for cost reduction. The meeting concluded with an invitation for questions and a note on a follow-up presentation scheduled for the next day, where further details on cost modelling would be shared.



Megha Choudhary and Alessandra Bergese during their presentation



Mrs. Choudhary and Mrs. Bergese during their presentation

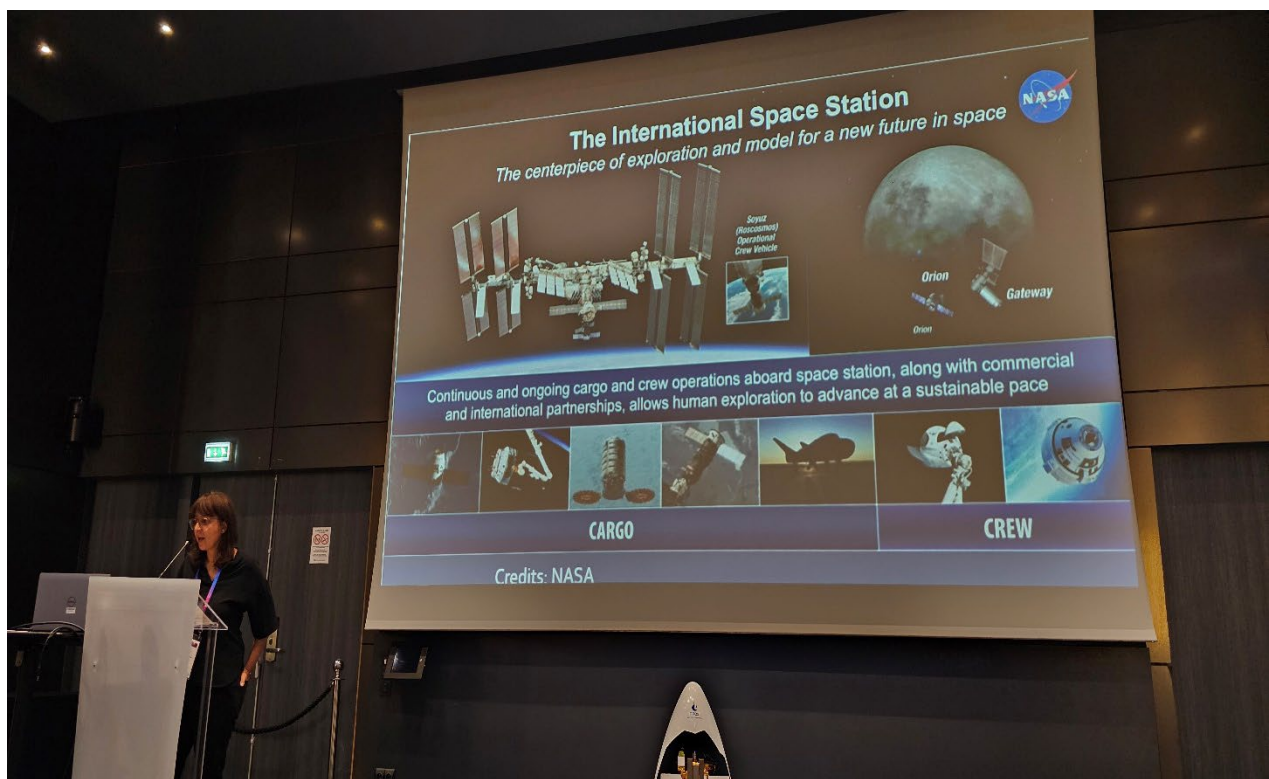
Session 9 -Commercialisation Lessons for future cis-Lunar missions

The speaker was Mrs. Stela Tkatchova - EIC Programme Manager for Space Systems, European Innovation Council and SMEs.



Mrs. Tkatchova during her presentation

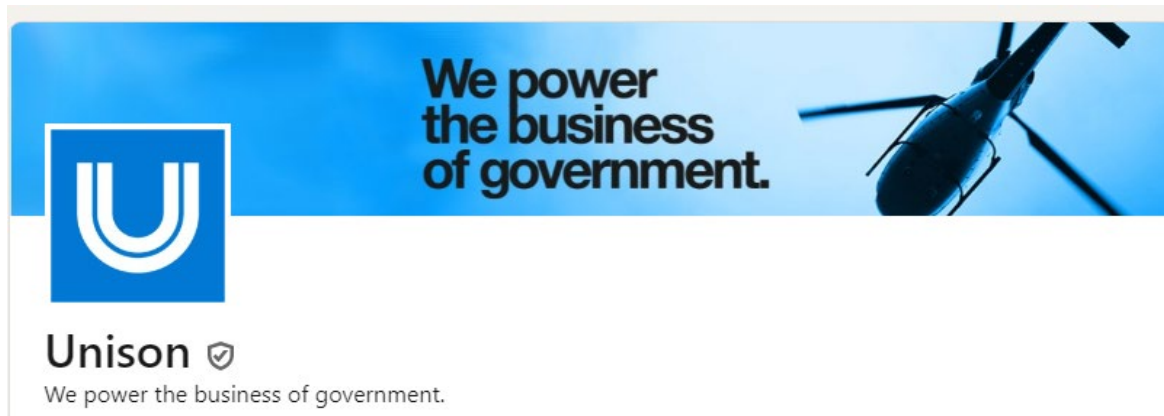
The meeting focused on the commercialisation of space missions, highlighting lessons learned from past projects, particularly the International Space Station (ISS) and NASA's Commercial Lunar Payload Services (CLPS). Key points included the importance of developing viable business models for space startups, the need for affordable technologies for lunar exploration, and the significance of understanding market demands and customer needs. The speaker emphasized the necessity for European companies to adapt and innovate in response to global competition, particularly from the U.S. and China. Discussions also covered the challenges of changing end-user requirements and the complexities of payload integration. Overall, the meeting underscored the need for collaboration among space SMEs and the importance of learning from past experiences to foster a sustainable future in the space industry.



Mrs. Tkatchova during her presentation

Session 10 – Model-based Cost Engineering Space Missions Estimating

The speaker was Mr. Chris Price (Unison Cost Engineering), Truth planning for cost estimation



The speaker discussed the methodology and tools used for estimating costs in space missions, particularly focusing on the True Planning software. Key points include:

Data Collection: The importance of collecting accurate data for estimates, including equipment types and subsystem details, is emphasized. New equipment types were developed specifically for space missions.

Subsystem Breakdown: The spacecraft and payloads are broken down into subsystems and components, with mass estimates and design parameters included for each component.

Estimating Methods: Two primary estimating methods are highlighted: the space missions estimate and the space equipment type model. The former was developed in response to NASA's need for better planetary mission estimates.

Historical Data Utilization: The use of a vast historical database, including data from the US Department of Defence, enhances the accuracy of estimates.

Case Studies: Two case studies were presented: the Luvot (LEO UV Optical Telescope) and the Mars Copter (Helicopter for Mars), showcasing the application of the estimating methods.

Comparison of Estimating Methods: A comparison between the two estimating methods reveals differences in estimates, with the space equipment type generally providing more conservative estimates for Earth orbiting missions.

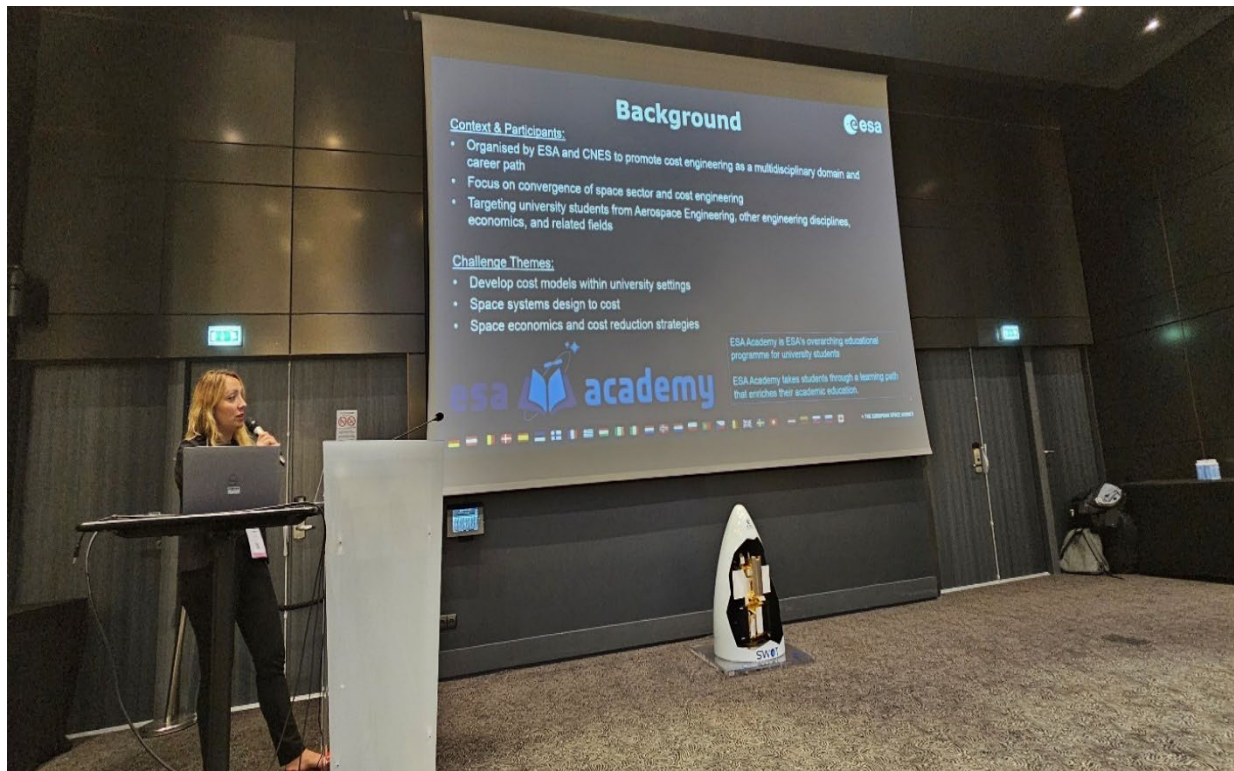
Future Enhancements: Discussions about potential future enhancements to the True Planning software, including the ability to model launch costs and system margins, were mentioned.

User Guidance: The importance of user input in refining estimates and the availability of support for users of the True Planning software were highlighted.

Session 11 – Student Poster Challenge introduction – Winner Student Poster Challenge presentation

The speaker was Mrs. Elisabetta Lamboglia (Cost engineer at ESA)

In this session, Mrs. Elisabetta Lamboglia, a Cost Engineer at the European Space Agency (ESA), presented an exciting new challenge to encourage students to explore cost engineering in the space industry. Organized by ESA and CNES, the challenge invited university students from engineering and related fields to develop cost models and cost-saving strategies for space missions.



Mrs. Lamboglia during her presentation,



Mrs. Lamboglia with the winners of the Student Poster Challenge "Megha Choudhary and Alessandra Bergese"

The session featured the winners of the Student Poster Challenge, Megha Choudhary and Alessandra Bergese from the University of Toulouse (their attendance was sponsored by the ESA Academy). They presented their "Dolphin Mission" feasibility study, which aims to create an affordable space mission to study interstellar dust within a budget cap of 175 million euros. After their initial cost estimates exceeded this budget, they made adjustments to the mission's design and chose a cost-effective thruster, Thrust NXT, though they noted it might face qualification challenges for geostationary orbit (GEO).

Using cost models like True Planning and the Small Spacecraft Cost Model, the team refined their estimate to 170 million euros, staying within budget. They also suggested more ways to reduce costs, like changing the stabilization method and relying on future technology advancements. They even calculated that if the launch were delayed to 2047, technology improvements might save up to 44% of the mission cost.

During the Q&A, the audience asked about the feasibility of the planned launch date and the factors affecting the 2047 cost estimate. The session ended with appreciation for the students' work and interest in using components like CubeSats to keep future missions affordable. This challenge highlights ESA's and CNEs efforts to get young engineers involved in creating cost-effective solutions for space exploration.

Session 12- Interactive Discussion about Artificial Intelligence and Cost Engineering - Opportunities? Threats?



Mr. Michel van Pelt and moderator Bruno Destrez during the discussion

The meeting focused on the integration of artificial intelligence (AI) in cost engineering and risk management, discussing both opportunities and challenges. Participants emphasized the importance of data quality and the need for human oversight in AI applications to avoid over-reliance on automated systems. Ethical considerations were raised regarding the potential for AI to replace jobs and the risks associated with trusting AI-generated outputs without critical evaluation. The conversation highlighted the necessity of understanding AI's

limitations, including issues like data hallucination, where AI may present incorrect information confidently. Overall, the meeting underscored the need for a balanced approach to leveraging AI, ensuring it serves as a tool to enhance human capabilities rather than diminish them.



Mr. Frederic Moll (CNES) and Mr. van Pelt during the discussion



The audience during the discussion

Session 13- Is it delusion, optimism, strategic misrepresentation or just an error?

The speaker was Mrs. Christine McLean. ACOSTE (Association of Project Controls and Cost Engineering Professionals)

The meeting focused on the complexities and challenges associated with space project management, particularly regarding cost estimation, project timelines, and the impact of human factors on safety and innovation. Key points included:

Cost and Timeline Challenges: The discussion highlighted that many space projects experience significant cost overruns and delays, with only about 5% of projects being completed on time. Factors contributing to these issues include design complexities, procurement delays, and political instability affecting funding.

Human Factors and Safety: Concerns were raised about the balance between health and safety regulations and the practical realities of space missions. The conversation questioned whether current safety practices might be overly cautious, potentially hindering progress.

Innovation and Risk Management: Participants discussed the need for a culture that encourages identifying opportunities rather than just threats, emphasizing that innovation often requires taking calculated risks.

Reference Class Forecasting: The importance of using historical data from similar projects to improve cost and timeline estimates was stressed. This method can help mitigate the effects of optimism bias in project planning.

Technological Development: The meeting acknowledged that many missions require the development of new technologies, which inherently adds risk and complexity. The need for realistic budgeting and timeline assessments was emphasized to avoid underestimating project requirements.

Overall, the meeting underscored the necessity for better communication, collaboration, and realistic planning in the management of space projects to enhance their success rates.

Session 14- COST GNSS reference station

The speakers were Mr. Rakul Lyngarathasan and Mr. Raphaël Baucryby at TERIA (a service provider whose aim is to increase the accuracy of Full GNSS real time positioning)



The meeting focused on the development of a GNSS (Global Navigation Satellite System) project aimed at reducing costs associated with receiver stations in France. Key discussions included the transformation of these stations into IoT objects, the use of various GNSS chipsets, and the implementation of a Linux-based system to enhance functionality and reduce expenses. The team highlighted a significant cost reduction achieved by utilizing the Mosaic X5 chip, which offers comparable performance to more

expensive integrated receivers. The project aims to optimize the cost structure further by exploring a system on a chip (SoC) architecture. Overall, the initiative seeks to improve competitiveness in the GNSS service market while maintaining high accuracy and reliability.

Session 15 - Examining Launch Family Composition in Light of Uncertain Launch Market Scenarios

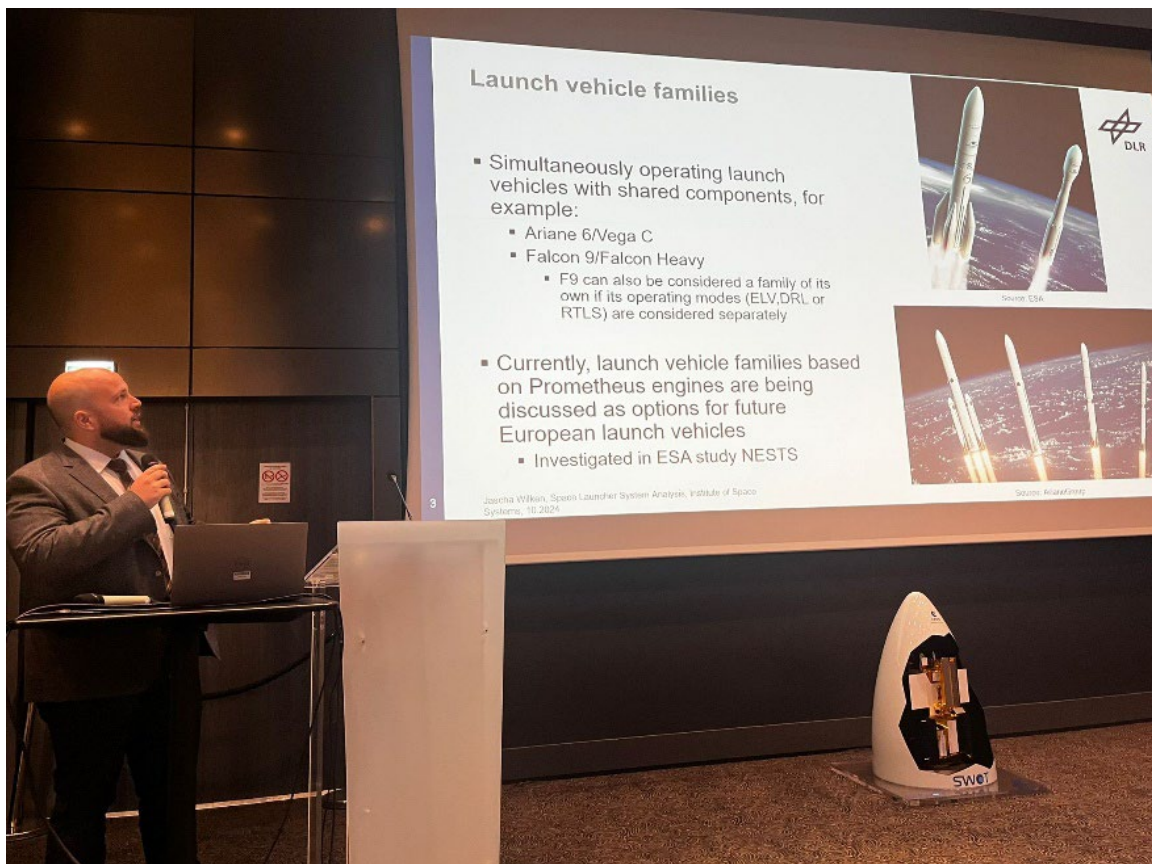
The speaker was Mr. Jascha Wilken Space Transportation System Analysis Department at DLR

The meeting reviewed future strategies for European launch vehicle families, focusing on balancing development and recurring costs, cost estimation challenges, and the significance of early design decisions. Key points included the need to anticipate market changes over the next 25–30 years, such as satellite constellation growth and rideshare missions. The Transcost model was used for cost estimation, though its limitations highlighted the need for updated data.

Main findings:

Reusable vs. Expendable Launch Vehicles: Reusable vehicles were found to be more cost-effective over time, even with lower market shares.

Monte Carlo Simulation: Simulations suggested that streamlined launch vehicle families perform best under market uncertainties.



Mr. Jascha Wilken during his presentation

Fuel Comparisons: Hydrogen and methane fuels showed similar performance outcomes.

Future Analysis: Plans include further work on vehicle sizing optimization, improved data integration, and refined trajectory management.

Contingency Management: The cost implications of satellite collisions were discussed, underscoring operational complexities.

These insights emphasize cost-efficiency and adaptability in launch vehicle design to meet evolving market needs.

Session 16 - ESA COsting Software (ECOS) (r)evolution for 2025

The speakers were Mrs. Carole Le Bay & Mr. Florent Michel Doullat (Cost engineers at ESA)

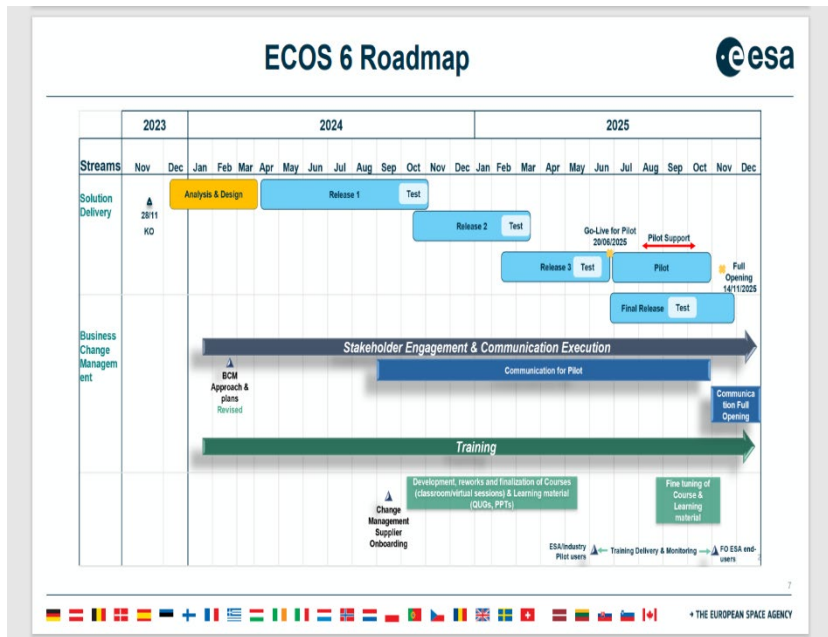


Mrs. Carole Le Bay (right) and Florent Michel Doullat (left) during their presentation

The meeting focused on the development and enhancement of the ESA costing software, specifically the transition from the current version (ECOS 5) to a new version (ECOS 6). Key objectives include improving user experience, enhancing interoperability with other tools, and ensuring better security and collaboration through incorporation in esa-star. The new version aims to streamline processes, reduce loading times, and allow for easier data import/export, particularly with Excel.

The development is structured in an agile manner, with multiple releases planned, starting with a test version expected by the end of the month. A pilot phase is set for mid-2025, during which real-life projects will use

the new system. Training and communication strategies are also being developed to facilitate user adaptation to the new software.



An extract of the Mrs. Le Bay and Mr. Doullat presentation

The meeting emphasized the importance of user feedback and collaboration with industry stakeholders to ensure the software meets their needs effectively. Future updates will include features for versioning and easier project management, with a focus on making the tool more accessible and user-friendly.

Session 17 – Wrap-up & Intro Next Conference



The meeting focused on the successful organisation and execution of the conference, highlighting the diversity and clarity of presentations that catered to a broad audience, including those less familiar with specific technical areas. Participants expressed appreciation for the interactive discussions, which enhanced engagement without the need for backup questions. The organisers emphasised the importance of feedback for future events, which are planned to occur biennially, with potential activities in the interim to maintain interest.

Overall, the atmosphere was positive, with attendees valuing the networking opportunities and the improvements made since previous editions.



The report author with other Cost engineering attendees networking
October 4th 2024