Winter 2024

IAF SPACE TRANSPORTATION COMMITTEE

Introduction

The objective of the Space Transportation Committee is to address worldwide space transportation solutions and innovations. In particular the goals are:

- To foster understanding and cooperation amongst space business academicians and practitioners, through the creation, diffusion, and adoption of new knowledge (i.e., research exploration, from academics to practitioners) and lessons learned (i.e., experience exploitation, from practitioners to academics).
- To build a worldwide network of communication and relationships between space business amateurs and professionals, by providing a forum of discussion, disclosure, creative thinking (i.e. brainstorming), and information sharing.
- To encourage, promote, and assist the development of newer members of the space community through IAC participation The corresponding activities are devoted to different types of space transportation missions, systems (launch vehicle system and/or the propulsion stages, expendable or reusable, manned or unmanned) and to their safety and support operations.

The activities of the IAF STC include the following:

- Proposal and organization of IAC symposium and sessions, including identification of relevant space-related topics to be included in the Call for Papers
- Participation in the paper selection as IPC members
- Participation as IPC members (Chairs, Rapporteurs and Symposium Coordinators) - Organization of dedicated conferences, publications
- Participation in the IAF Committee Briefs and the annual IAF Highlights

Highlights

D2.1 – Launch Vehicles in Service or in Development:
Review of up-to-date status of launch vehicles currently in use in the world or under short term development

The main highlight of D2.1 was the strong representation of China showing real progress on different new launch vehicles (Papers #1, 4, 6). The important and interesting Japanese paper on H3 was unfortunately not presented. Considering American launch vehicles, a paper on SLS “Unique Launch Capability” of potential future missions was presented. Unfortunately, Europe did not submit an abstract on Ariane (5 or 6 both being relevant in 2023) and only one on Vega C. The latter not addressing the failure and return to flight action but focusing on potential future GNC-upgrades.

D2.2 – Launch Services, Missions, Operations, and Facilities:
Review of the current and planned launch services and support, including economics of space transportation systems, financing, cost, insurance, licensing. Advancements in ground infrastructure, ground operations, production methods, mission planning and mission control for both expendable and reusable launch services.

Session D2.2 had a lower attendance compared to other IACs and some challenges with various organizational decisions on non-participation, but at the end it has been a full and robust session, with a complete complement of papers. The session was well-balanced across geography, gender, and generation, including papers from Africa, US, Kourou, and the EU, and a student paper from Italy covering the evolution of the European launch base to a next generation launch site, the implementation of a digitally transformed factory for the future of the Space Launch System (SLS) and prospects + selection of launch sites in Ethiopia and Peru.

D2.3 – Upper Stages, Space Transfer, Entry & Landing Systems:
Discussion of existing, planned or new advanced concepts for cargo and human orbital transfer. Includes current and near-term transfer, entry and landing systems, sub-systems and technologies for accommodating crew and cargo transfer in space.

The session was well attended with interesting presentations on new developments from The Exploration Company with their Nyx Earth LEO return Capsule. Other presentations covered the development of an inflatable heat shield as well as the development of a drogue parachute + recovery operations of student rocketry. Also, the development of a supersonic parachute for Mars exploration was presented and the status + planned evolutions of the GC activities on Space Rider. Unfortunately, the only paper was a non-European paper.

D2.4 – Future Space Transportation Systems:
Discussion of future overall transportation system designs and operational concepts for both expendable and reusable systems for Earth-to orbit transportation and exploration missions.

An interesting session was given with presentations on activities in Europe w.r.t. re-useable launch vehicles, on Space Liner and re-useable SSTO or point-to-point launch vehicles. Also, space transportation solutions for moon and Mars missions have been presented.

D2.5 – Technologies for Future Space Transportation Systems:
Discussion of technologies enabling new reusable or expendable launch vehicles and in-space transportation systems. Emphasis is on early TRL hardware development and verification prior to flight, including ground testing and/or innovative technology prototype demonstrations not yet involving flight.

The session had 4 papers presented (out of the 11 initially accepted). The papers focused on: (1) new automatic optimisation techniques for launch vehicles' attitude control laws, (2) architecture and mission analysis of in-air capturing of a winged reusable launch vehicle, (3) design, development, and qualification of the Space Rider thermal protection system, and (4) fault diagnosis methods for electromechanical actuators in the TVC system. The main highlights out of the presentations have been: Development of frameworks for the automatic optimisation of linear attitude control laws in launch vehicles during ascent, marking a significant advancement, comprehensive analysis of mission design and dispersion analysis for in-air capturing of wing-featured reusable launch systems, showcasing interesting strategies, detailed overview of the development and qualification of re-entry thermal protection systems focusing on the VEGA Space Rider, highlighting key advancements and innovative approach to diagnosis methods for fault detection in TVC Systems, leveraging redundant heterogeneous sensors of the electromechanical actuators, representing an interesting advancement in system reliability.

Overall, despite the reduced number of papers presented due to cancellations induced by the location, the topics covered were well aligned with the objectives of the session and provided interesting insights.

D2.6 – Future Space Transportation Systems Verification and In-Flight Experimentation:
Discussion of atmospheric and in-space flight testing and qualification of system, sub-system, and advanced technologies for future launch vehicles and in-space transportation systems. Emphasis is on higher TRL in-flight experimentation, demonstration, and qualification, including test plans and innovative technology prototype…

The D2.6 session on Future Space Transportation Systems Verification and In-Flight Experimentation had a full session with papers representing seven different countries. Included in the session were papers covering reusable rockets, the Space Rider reentry vehicle, reusable launch vehicles, a supersonic parachute, a reentry capsule, and design and research on rocket systems.

D2.7 – Small Launchers: Concepts and Operations:
Discussion of existing, planned and future Launchers for small payloads ranging from 1500 kg to as low as 1 kg into Low Earth Orbit. Includes innovative solutions such as airborne systems, evolutions from sub-orbital concepts, combinations of existing / emerging elements and new elements, reusable, partially reusable and expendable concepts, and flexible, highly responsive concepts…

The session was very well attended with a high number of presentations from all over the world covering different aspects of small launch vehicles. The session was started with the classical market overview on smallsat activities and its implications on the small launch market by Bryce Tech. Main highlight of the session was the presentation of the launch campaign status for the MIURA re-useable European micro launcher which was successfully launched just after the IAC2023. But also, the other presentations from Asia and on student rocketry were very interesting.

D2.8 - Space Transportation Solutions for Deep Space Missions
This session is focused on in-space transportation capabilities and mission architectures, existing or under study, for human deep space exploration missions as well as the driving scientific mission objectives. Related enabling and support missions, such as robotic servicing and supply, as well as technology roadmaps to achieve successful deep space exploration missions shall be discussed. The session will also deal with lessons learned from past deep space missions beyond LEO as well as worldwide needs, requirements, and international cooperation to implement large scale exploration missions.

Session D2.8 was not well attended. The most interesting paper was "Control program for a multi-type electric propulsion system for the Earth-Mars-Earth-Jupiter mission" presented by Prof. Olga Starinova. In the paper and presentation, Prof. Starinova showed the feasibility to increase Isp by using a vehicle with different types of electric propulsion thrusters. The algorithm presented turned different banks of thrusters on and off depending on the mission demands. Several nuclear propulsion concepts and a novel "skyhook" slingshot concept were also presented during the session.

D2.9 - Emerging Space Ventures, including Space Logistics and Space Safety for Sustainability
This session is dedicated to discussions of technical innovations or initiatives to achieve sustainable (considering cost, operability, capability, and impact) Space Transportation Systems. Of particular interest are:
- Identification of core evolving capabilities (systems, components, technologies) to conduct increasingly complex missions to a range of destinations over time - Addressing of emerging Space logistics, safety, technical challenges to foster flexible mission architectures using interoperability of building block components, and avoiding "one mission for one goal" (i.e. Single destination systems)

The session had 8 papers approved for presentation at the 2023 IAC event. The session attracted a good audience. Four papers were presented, covering interesting topics and receiving positive feedback from the audience. The papers covered diverse subjects: a) "OPALS advanced Kick Stage and Space Logistics vehicle architecture and innovative technologies" by Mr. Arturs Jasjukevics; b) "Comparison of the Environmental Impact of Production and Launch Emissions of Different Common Launcher Architectures" by Mr. Jan-Steffen Fischer; c) "Cost Estimation for Innovative Space Systems: A Methodology for Microlaunchers and Inflatable Heatshields" by Mr. Giuseppe Governale; d) "The Role of Small Launch Vehicles in Democratizing Access to Space" by Ms. Zahra Gasimova.

Committee Activities

The committee is currently made of more than 70 members from all over the world including South America, Australia, North America, Europe and Asia. Only no member from Africa is currently given. A good distribution is given with a high number of female members and young professionals + students and a good distribution among categories (industry, Academia, agencies).

The committee is not only active in the organization of the International Astronautical Congress, but also fosters synergies with other relevant space transportation conferences, and, tries to improve the exchange between the committee members through regular, committee internal webinar sessions, the last one in February 2023 on Artemis I results.

A long discussion has taken place during the 2023 spring meeting, the IAC2023 conference and an extraordinary committee meeting in October 2023 to discuss the future definition of the technical sessions organized by the committee and here especially the IAC 2024 in Milan, Italy. Two sessions were modified to give a higher attention to student rocketry and sustainability of launch vehicles considering the impact of launch vehicles on the environment.