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Author: Mrs. Emmanuelle Aubert
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France,
emmanuelle.aubert@student.isae-supaero.fr

Mr. Antoine Carré
SUPAERO- Ecole Nationale Supérieure de l'Aéronautique et de l'Espace, France,
antoine.carre@student.isae-supaero.fr
Mrs. Pauline Delande
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France, pauline.delande@gmail.com
Mr. David Gaudin
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France, david.gaudin@estaca.eu
Mr. Pierrick Vivares
SUPAERO- Ecole Nationale Supérieure de l'Aéronautique et de l'Espace, France,
pierrick.vivares@student.isae-supaero.fr
Mr. William Zhang
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France, william.zhang@student.isae-supaero.fr

SPACE TUG: THE FUTURE OF LEO TO GEO TRANSPORT

Abstract

Telecommunications satellites have seen their performance and lifetime greatly increase in recent decades. However, these improvements have reached the limits of chemical propulsion efficiency and launcher capacity. Ariane 5's maximum capacity is approximately 5 tons per satellite in dual Geostationary Transfer Orbit launch, of which about half is dedicated to propellants that will allow Geostationary Earth Orbit circularization and orbit maintenance.

This limitation has encouraged the development of electric propulsion for telecommunications satellites, leading to innovating perspectives on a new space transportation model. A model in which telecommunication satellites would be completely devoid of the dead weight that represents engines and ergol tanks dedicated to circularization. A model in which the transport from LEO to GEO would be accomplished by an electrically propelled Space Tug. In this model, satellites whose weight would be reduced to 2 to 3 tons would be launched in LEO by small launchers. There, satellites would be taken in charge by a Space Tug, transporting them to their final geostationary location by a 3 to 4-months journey.

This space transportation model offers two advantages; not only does it break the payload mass limitation of telecommunications satellites caused by traditional launchers but also allows the reduction of the actual cost of accessing the geostationary orbit by using a lightweight launcher and a highly efficient and reusable Space Tug. Moreover, this reduction in GEO access costs paves the way for other GEO New Space contributors and enables viability of GEO Hubs, Servicers, Undertakers and Recyclers.

In this paper, a presentation of a Space Tug preliminary design will be made, as a potential answer to the new space transport paradigm. Starting with a market analysis, a mission analysis is held to assess the requirements at the spacecraft level. The technical design being articulated around the critical

points, special focuses will be made on resistance towards the harsh environment met during the multiples journeys, propulsion and power supply trade-off in order to maximize the Space Tug economic efficiency. The preliminary design will be revealed presenting the Space Tug accommodation (including rendezvous and docking system, radiation mitigation, thermal regulation, communication, OBDH, etc..) with the system budgets. Finally, a business plan with cost and profit will be depicted, showing the interest of such a solution in the lowering of GEO access costs.