

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Future Space Transportation Systems (4)

Author: Ms. Sara Cresto Aleina  
Politecnico di Torino, Italy, sara.cresto@polito.it

Dr. Nicole Viola  
Politecnico di Torino, Italy, nicole.viola@polito.it

Mr. Matteo Dentis  
Politecnico di Torino, Italy, matteo.dentis@polito.it

Mrs. Simona Ferraris  
Thales Alenia Space Italia, Italy, simona.ferraris@thalesaleniaspace.com

Mr. Paolo Maggiore  
Politecnico di Torino, Italy, paolo.maggiore@polito.it

Dr. Maria Antonietta Viscio  
Politecnico di Torino, Italy, Maria.Viscio-somministrato@thalesaleniaspace.com

## REUSABLE SPACE TUG CONCEPT AND MISSION

**Abstract**

The paper deals with the conceptual design of a space tug to be used in support to Earth satellites transfer maneuvers. Usually Earth satellites are released in a non definitive low orbit, depending on the adopted launcher, and they need to be equipped with an adequate propulsion system able to perform the transfer to their final operational location. In order to reduce the mass at launch of the satellite system, an element pre-deployed on orbit, i.e. the space tug, can be exploited to perform the transfer maneuvers; this allows simplifying the propulsion requirements for the satellite, with a consequent decrease of mass and volume, in favor of larger payloads. The space tug here presented is conceived to be used for the transfer of a few satellites from low to high orbits, and vice versa, if needed. To support these maneuvers, dedicated refueling operations are envisaged. The paper starts from an overview of the mission scenario, the concept of operations and the related architecture elements. Then it focuses on the detailed definition of the space tug, from the requirements' assessment up to the budgets' development, through an iterative and recursive design process. The overall mission scenario has been derived from a set of trade-off analyses that have been performed to choose the mission architecture and operations that better satisfy stakeholder expectations: the most important features of these analyses and their results are described within the paper. Eventually, in the last part of the work main conclusions are drawn on the selected mission scenario and space tug and further utilizations of this innovative system in the frame of future space exploration are discussed. Specifically, an enhanced version of the space tug that has been described in the paper could be used to support on orbit assembly of large spacecraft for distant and long exploration missions. The Space Tug development is an activity carried on in the frame of the SAPERE project (Space Advanced Project Excellence in Research and Enterprise), supported by Italian Ministry of Research and University (MIUR), and specifically in its STRONG sub-project (Systems Technology and Research National Global Operations), related to the theme of space exploration and access to space.