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NEAR-EARTH ASTEROIDS UTILIZATION AS A BASE FOR BUILDING OF EARTH-MARS-MOON ECONOMY

Abstract

Recently, a lot of of attention has been brought to the deep space mining missions. Mining of the natural resources from near-Earth celestial bodies like Moon, near-Earth asteroids (NEAs), comets and meteors is one of the possible ways for solving of the problem of lack of natural resources on Earth. The calculations in the article show that current cost of the launch and space mining technology readiness level do not allow us to implement extraterrestrial resources to Earth economy, due to the extremely high cost comparing to the terrestrial resources.

The goal of this paper is to estimate economical benefits of asteroid mining for Moon and Mars colonies. We know from planetary research programs that water resources on the Moon are limited and most of them are possibly concentrated near the South Pole. On Mars, we know that water ice is concentrated near the polar regions in form of ice (Polar Layered Deposits) or near-surface permafrost. In order to enable in-situ resource utilization (fuel generation, building materials etc) a number of additional materials have to be brought to the Moon or Mars.

We propose to consider a network economy that includes Near-Earth Asteroids (NEA), Earth, Moon, asteroid belt, Mars and its satellites as a source of materials for solar system colonization. For example, materials contained in NEA may be very useful to this task. Approximately 10% of known NEAs are more accessible than the Moon in terms of required delta-V for transfer. Moreover, asteroids are a possible source of platinum group metals (PGM) and water according to the ground observations.

To simulate scenarios on colony growth, material transfer and asteroid exploitation, we would like to utilize multi-agent network optimization. We can map agents acting in the solar system economy to well proven solutions in dynamic optimization for truck delivery systems. We have constructed a simple ontology that includes colonies (resource requests), spacecraft (resource transport), asteroids (resource supply), satellites (resource depot). We have specified cost functions of delivery and resources availability to model transportation of water and other materials (e.g. PGMs) between actors in the solar system.

The goal of this modeling is to understand key technologies that will be required inside such network to prepare development roadmaps today. Also, we are interested to model possible sizes of colonies of Mars and Moon to make asteroid mining economically sensible.