Paper ID: 17863
oral

SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

Author: Dr. Jesús Gonzalo
University of León, Spain

Dr. Diego Domínguez
Vrije Universiteit Brussel (VUB), Belgium
Mr. Deibi López
University of León, Spain

THE HUNDRED-YEAR SATELLITE

Abstract

This paper reviews the current space technologies from the lifespan point of view, providing guidelines to setup a hundred-year-lifetime mission to deliver messages to our descendants in a cost-efficient manner.

The discussion includes trade-off's for orbital profiles, radiation hardening, thermal protection, energy harvesting and accumulation, data storage and communications, all together combined with reliability enhanced mechanisms as homogeneous and heterogeneous redundancy and system-level solutions like smart hibernation policies.

Very low orbits constrain lifespan due to atmospheric drag, the impact of which depends on the shape and mass of the satellite. Very high orbits are more expensive and prone to solar wind and stronger radiation doses. In between, the environment is more benign, making the region more crowded by active missions and uncomfortable debris, so that the risk of fatal collision increases. On top of all that, the magnetosphere can help a little if low inclinations are selected.

With respect to radiation, several semiconductor technologies are more immune to the continuous particle bombing. Ionization, atom movement or absorption produce changes in material properties that need to be managed. The selection of the proper technology, together with physical protections and fault-tolerant designs provide successful performance if the radiation environment is not extreme (avoiding South Atlantic anomaly, for example).

Solar panels are currently a concern when estimating the lifespan of a space system. A complete review of technologies is provided. However, depending on the power requirements and in order to be able to catch enough energy for minimum operation after a century, imaginative mechanical solutions may be required, so that certain panels are only released (and exposed to solar radiation) when waking up from hibernation.

Finally, the status of mass-memory technologies is reviewed, including those more promising from the radiation and thermo-mechanic cycling points of view. Special attention is paid to non-volatile memories, as they are perfect for the envisaged mission.

Several satellite concepts are provided to stimulate the discussion on the possible evolution of the state of the art, preparing a new mission to take advantage of the persistence of satellites in orbit to serve a new communication need, the one with/to our descendants.