Paper ID: 88368
student

52nd IAF STUDENT CONFERENCE (E2)
Student Conference - Part 2 (2)

Author: Mr. Lucas Scherberger
Fraunhofer - Institut für Kurzzeitdynamik, Ernst-Mach-Institut (EMI), Germany

Dr. Frank Schäfer
Fraunhofer EMI, Germany

SIMPLIFIED METHOD FOR PREDICTING THE SYSTEM RESPONSE TIME OF SATELLITE CONSTELLATIONS

Abstract

The demand for real time availability of satellite earth observation data is steadily increasing and has been driving the creation of large satellite constellations. Hence, predicting the system response time (SRT) for satellite earth observation data acquired by a satellite constellation is an important step required for designing a satellite constellation to ensure its performance, cost-effectiveness, and sustainability.

In this paper, a simple yet effective method is proposed for estimating the SRT. The system response time is defined here as the time interval between a user's data collection request for earth observation imagery from an arbitrary target point on earth and the receipt of the requested data at the user's location through the satellite constellation and its ground stations. In previous work, earth-observing satellite constellations and ground station networks could be optimized for easier metrics like the average revisit time for a specific target. However, a systematic method for evaluating the SRT globally is missing.

The method that is presented here computes the access time intervals of every satellite of the constellation to every ground station of the network. A chosen simulation interval is discretized into equally spaced time points and a Monte-Carlo simulation for the observation targets is performed at each time point. Based on the access intervals of the satellite constellation to the ground stations, the SRT is calculated for each discretized time point and target of the Monte-Carlo simulation. Averaging the SRT over the time points extracts the time-independent information. Meaningful metrics such as the average and maximum SRT of the targets, as well as quantiles of all SRT, are introduced, combined with a visualization on a world map, allowing to quickly grasp the strengths and weaknesses of the constellation with regards to SRT.

Investigating the SRT as a function of target latitude [-90°,90°], the upper and lower envelope was found to have the shape of a bell curve in most practical situations. The shape of this curve is strongly dependent on number and design of both the satellite constellation and the ground station network. Furthermore, the case of a constellation consisting of one satellite and one ground station is investigated, to model and explain the impact of the ground station latitude on the global average SRT. The method was implemented in Python using the orbital mechanics algorithms of STK.