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INTEGRATED FRAMEWORK FOR HIGH FIDELITY SIMULATION OF DISTRIBUTED SYSTEMS OF SATELLITES AND GROUND VEHICLES

Abstract

The trend in space industry towards distributed satellite systems (DSS) leads to a high demand of the development of advanced communication protocols and orbit control algorithms. Future satellite systems depend on intersatellite communication to establish and maintain formations e.g. for Earth observation and communication services. Also ground stations and user devices on ground need to establish communication links with the satellite system. Single satellite systems are usually intensively tested on ground before launch to make sure all systems work as desired. Testing of DSS is much more challenging since the operational capability of those systems highly depends on orbital dynamics. Although communication effects and orbit perturbations can be replicated on ground for testing purposes to some extend, for DSS the coupling of these effects calls for new approaches based on high fidelity simulations. For the individual areas of interest, e.g. communication, orbit and ground dynamics there already exist expert simulation tools, but none that combines all aspects into a single coherent framework. In this work we present a simulation framework that allows for high precision simulation of trajectories of satellites and ground vehicles, combined with detailed analysis of communication channels and protocols. Our framework is based on the well-established open-source tools OMNeT++ and Orekit. The challenges involved with the integration of several specialized simulation frameworks are discussed and solutions are presented. Due to the modular design our framework is customizable and expandable to the needs of each specific mission. Exemplary simulation results are presented and the main areas of application are pointed out. At the end an outlook to prospective hardware-in-the-loop simulations is given, showing complementary test facilities for verification of specific aspects, such as attitude and position control.