SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Space Systems and Architectures Featuring Cross-Platform Compatibility (7)

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A PERFORMANCE COMPARISON OF DIFFERENT SATELLITE RANGE SCHEDULING ALGORITHMS FOR GLOBAL GROUND STATION NETWORKS

Abstract

Large-Scale ground station networks like GENSO (the Global Educational Network for Satellite Operations), a project under supervision of ISEB (International Student Education Board), are designed to interconnect several hundreds of ground stations supporting a large amount of different space missions. Such a large amount of stations and satellites results in hundreds of thousands of satellite passes tracked by the connected stations each day.

Depending on the examined scenario, a satellite pass is mutually exclusive for ground stations (and spacecrafts): One ground station can only track one spacecraft at a time (valid for uni- and bi-directional communication) and one spacecraft can only communicate with one ground station at a time (valid for bi-directional communication). Consequently, for tracking ground stations the majority of satellite passes is conflicting with other passes. In order to resolve these conflicts under consideration of several criteria satellite range scheduling algorithms are applied.

Satellite range scheduling is a scientific domain since the 1960s and a diversity of generic planning and scheduling techniques has been applied to this specific problem. Though, due to the novelty of large-scale ground station networks, hardly any approach has yet been performed and published solving the specific needs of such kinds of networks.

Using a novel generic framework for scheduling, simulation, and optimization of ground station networks several different scheduling algorithms have been implemented, optimized and benchmarked. Amongst others, the following algorithms have been studied: basic random selection, first-come-first-serve, greedy selection with different optimization functions, and graph-based hybrid round-robin. All algorithms are benchmarked within several scenarios with different amounts of spacecrafts, ground stations and scheduling durations. All results are compared with the average performance of stand-alone ground stations in order to elaborate the optimization potential of ground station networks compared to current stand-alone setups.

The performance of the different scheduling algorithms is investigated respecting the following aspects: Communication duration between ground and space, mission data return, uninterrupted communication timeframes (for continuous data transmissions by "station hand-over" using several ground stations),

signal to noise ratio, bit error rate, packet error rate, and others. Additionally the resource consumption (runtime, memory) and scalability is observed and compared.

The benchmark results lead to a proposal for a specific centralized scheduling algorithm for large-scale ground station networks resulting in more than 20