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Author: Prof. Marco Schmidt
University Wuerzburg, Germany

Prof. Klaus Schilling
University Wuerzburg, Germany

DATA COMBINATION MECHANISM IN HIGHLY DISTRIBUTED GROUND STATION NETWORKS

Abstract

Due to the huge success of small satellite development more and more academic ground station networks have been established (e.g. GENSO [1] or Mercury). These networks differ in many ways from classical ground networks, like operated by ESA or NASA. Main difference of this new ground segment approach is the network topology, consisting of a large number of low-cost ground stations loosely coupled through the Internet to a network [2]. The radio hardware of these ground stations provides only a limited transmission rate, but an innovative approach is to have many nodes in the network to receive signals from a satellite in parallel. Such a network topology with a large number of nodes enables the application of advanced data management methods, which is not possible in classic ground station networks, as these contain specialized stations which are not intended to track a satellite with several ground station in parallel.
The paper introduces a new algorithm for data combination in academic ground station networks. The algorithm uses the inherent redundancy in those networks in two different steps: In step 1 the received data packages in the network are synchronized by a central entity, because they are subject to delays in the network. In low earth orbits (LEO) the delay on the radio link is comparably small, the delay induced through the Internet is larger and more variable. Fortunately the delay from the internet can be estimated with time synchronization algorithms [3]. Therefore synchronization on data packet level is achievable with relative simple means as explained in the paper.
In the next step the data combination algorithm analyses the obtained data and uses the redundant received information to reconstruct data gaps. In parallel received packets can be compared from a central entity in the network to reconstructed corrupted data. The paper will present a mathematical evaluation and proves the concept for small ground station networks with hardware experiments.

[1] Page, H.; Preindl, B. Nikolaidis, V.; GENSO: The Global Educational Network for Satellite Operations. Proc. 59th International Astronautical Congress (IAC'08), Glasgow, Scotland. 2008

[2] Schmidt, M. Schilling, K.; Evaluation of the CUSS scheduling system with respect to real world scenarios. Proc. 60th International Astronautical Congress (IAC'09), Daejeon, Korea. 2009

[3] Mills, David L.: NTP Interleaved On-Wire Protocol for LANs and Space Data Links. Newark, University of Delaware, 2008