DATA COMPRESSION OF SCIENCE AND HOUSEKEEPING DATA FOR PLANETARY PROBE MISSIONS

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ABSTRACT

For all types of space missions, the available bandwidth for the transmission of data back to Earth is an important constraint with significant impact on vehicle design, onboard resources, and mission operations. This is particularly true for planetary probe missions aiming at bodies in the outer solar system. The efficient compression of science and housekeeping data allows maximizing the utilization of the available bandwidth and reducing the requirements for onboard mass memory size. Further advantages include the potential to reduce the energy required for data transmission. While the use of data compression is generally accepted for science / payload data, it has often been avoided for spacecraft housekeeping data. This should not be accepted for exploration and science missions that have significant bandwidth constraints.

Data compression can be implemented in hardware or software. In order to minimize the added complexity needed for the implementation, algorithms are required that provide high compression performance at low cost in terms of operations per data bit (for software implementation) or in terms of hardware requirements (for implementation in digital electronics). The compression method should also minimize error propagation in the data. The standardization of performant algorithms supports the availability of high quality documentation and the establishment of a broad user community for the selected algorithms.

ESA has, in cooperation with major space agencies, supported the development and standardization of efficient data compression algorithms that provide high performance as well as low resource requirements. Algorithm specifications, test data, implementation guidelines and some software code are available via the services provided by CCSDS [1], ESA [2], and other agencies.

We first present an overview of present and upcoming standardized data compression algorithms. Their compression performance and resource requirements on typical space platforms as well as the sensitivity of compressed data to errors are addressed. A new ESA software tool for the evaluation of standardized data compression algorithms for use by industry and payload teams is introduced. The combination of efficient pre-processing steps with standardized compression for achieving significant performance gains is proposed, and test results for the compression of typical data sets are presented. The benefits of telemetry pre-processing and compression for planetary probe missions are explained, and recommendations are made for implementations on future missions.

[1] CCSDS website at
http://public.ccsds.org/publications/default.aspx

[2] ESA TEC-EDP website at
http://www.esa.int/TEC/OBDP/