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OPTICAL COMMUNICATION SYSTEMS FOR MICRO- AND NANO-SATELLITE APPLICATIONS: CURRENT STATUS AND FUTURE TRENDS

Abstract

Optical communication for spacecraft has been gaining more and more attention in the last years because it provides an attractive solution to the increasing requirements of high data rate communications, while traditional radiofrequency communication moves towards link limitations such as throughput and total capacity. In addition, interesting novel applications such as Low Earth Orbit links, satellite crosslink, deep space links, and even a network between Moon and Earth are foreseen based on optical communications. Naturally, this technology also comes with novel challenges which can be mainly resumed to extremely precise pointing requirements as well as atmospheric effects for satellite-ground or (very) low-earth orbit links. Moreover, when it comes to small satellites with a mass lower than 100 kg, complying with the requirements of size, weight, and power is an additional challenge. With the trend of moving away from large monolithic integrated spacecraft to constellations and formations of smaller satellites, these constraints need particular attention in the development of future optical communication equipment targeted to small satellites. However, there are only just a few missions that applied optical communication systems in micro- and nano-satellites with demonstrable in-orbit results so far among which two stand out: the Small Optical Transponder (SOTA) project developed by the National Institute of Information and Communications Technology, Japan, and the Optical Space Infrared Downlink System (OSIRIS) project developed by the German Aerospace Center. They have currently proven achievable data rate speed of 10 Mbps and 1000 Mbps with a terminal mass of around 5 kg. In this contribution, both projects performance and results will be reviewed. Due to their successful demonstrated results, other players have also joined to this trend and are currently developing their own optical terminal. Their current reported performance will be also mentioned here. Concluding the contribution with performance trade-off graphs in terms of terminal mass, data rate, and bit error rate; current optical terminal developments for small satellites that address to improve the current performance and fulfill the needs of envisioned applications presented in the literature up today are summarized and an outlook on future trends and developments is given.