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INVITED PAPER: HIGH DATA RATE LASER COMMUNICATION FOR OPERATIONAL SERVICES

Abstract

Today, optical inter-satellite links are ready for commercial operational services. Verified in-orbit for years they demonstrate reliable data transmission far in the Gigabit per second range. On a repeatable basis bit error rates of 10-11 have been verified for an uncoded 5.625 Gbps data link between two LEO satellites, i.e. for a link distance of about 5,000 km. The communication link is established within seconds. Pointing, acquisition and tracking have been verified as reliable and robust. The high data rate laser communication link verified in-orbit is based on homodyne BPSK, the most sensitive modulation scheme. Homodyne BPSK also is sensitive for space-to-ground and ground-to-space communication. 5.625 Gbps LEO-to ground and even 5.625 Gbps ground-to-LEO links have been verified with excellent bit error rates. Using adaptive optics on ground the aperture of the ground telescope can be increased to collect a sufficient number of photons per bit to establish high data rate GEO-to-ground links. By optimized transmit power high data rate links can be established from UAV-to-GEO. Future earth observation satellites call for high data rate down-links of high availability to make their data immediately available to the user. These requirements will only be achieved by optical GEO relays. The GEO relay extends the availability from minutes per day as is the case for the direct LEO-to-ground link to 12 hours per day and the optical communication link extends the GEO relay's capacity which today is limited by RF communication to about 1 Gbps into the 10 Gbps range. Based on the results of the in-orbit verification mentioned above, EDRS, the European data GEO relay system will be equipped for the time being with 1.8 Gbps laser communication terminals for the LEO-to-GEO link. However, the today's GEO relay's capacity is limited by the RF down-link to 1Gbps. Therefore, active optics for a GEO-to-ground down link of the same data rate as the optical LEO-to-GEO link is under development and has been successfully verified in a free-field measurement campaign. Laser communication based on homodyne BPSK is well suited for data relay systems, i.e. ground-to-space, UAV-to-space, inter-satellite and space-to-ground with a data rate still scalable by further terminal optimization.