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# THE VISION - CONCEPT OF LASER CROSSLINK SYSTEMS USING NANOSATELLITES IN FORMATION FLYING

## Abstract

A recent growth in data volume from space missions can be dealt with a laser communication which enables a super high speed data transfer faster than 1 Gbps. Compared to traditional RF systems, the laser communication systems enhance the SWaP (Size, Weight, and Power) efficiency at low-cost. Beam features related with a wide spectral range and narrow make a link security improved, significantly mitigating potential risk from mutual interferences, jamming, and signal intercept from others. These advantages of the laser communication are applicable to high-speed data relay in commercial and defense fields, spaceborne remote sensing or surveillance; additionally, as a frequency band of the laser is free from regulatory constraints, it is a promising method to establish a LEO mega-constellation. We proposed novel systems for a space-to-space laser communication, the VISION (Very high-speed Inter-satellite link Systems using Infrared Optical terminal and Nanosatellite); it is aimed to establish and validate the laser crosslink systems and several space technologies using two 6U nanosatellites in formation flying. The final mission goal is to accomplish a data rate of 1 Gbps at an inter-satellite distance of up to 1000 km. The payload is the 1 W-level LCT (Laser Communication Terminal) with a deployable space telescope as a front-end optics, enhancing gain of beam transmission and reception relevant to a large aperture. The deployable space telescope consists of five segmented mirrors and three boom struts, having a full aperture of 200 mm; as a launch configuration, it can be contained in 2U. The LCT shares beam paths for communication and the PAT (Pointing, Acquisition, and Tracking) with a single aperture; this mono-static architecture can provide a closed-loop feedback for the PAT without steady-state beam pointing errors. The nanosatellites include a precise formation flying GNC (Guidance, Navigation and Control)

system with S-band RF inter-satellite link system and propulsion system. The attitude control system including a star tracker and 3-axis reaction wheel assembly assures pointing and tracking errors within tens of arcsec. The fine relative navigation system based on the differential GNSS algorithm uses both GPS L1 and L2 signals to eliminate effects of ionospheric delay. Unlike other laser crosslink systems using nanosatellite platforms, both nanosatellites are equipped with the propulsion system and can change the inter-satellite distance rapidly and accurately as following mission operation scenarios. This proposed concept of the laser crosslink systems will contribute to construct the high-speed space-to-space network at low-cost in future.