International Laser Ranging Workshop, Annapolis, MD, USA, October 26-31, 2014

Time Transfer by Laser Link (T2L2) : A way to synchronize laser ranging observatories at the ns level

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Abstract.
The Time Transfer by Laser Link (T2L2) experiment, a passenger of the Jason-2 satellite, was developed by both OCA and CNES to perform ground to ground time transfer between remote clocks. The principle is derived from laser telemetry technology with dedicated space equipment designed to record arrival time of very short laser pulses at the satellite. Using laser pulses instead of radio frequency signals, T2L2 allows realizing some links between distant clocks with time stability of a few picoseconds over 1000 s and accuracy of the order of 100 ps. Several experiments demonstrated the capability of the T2L2 system to perform time transfer between ultra-stable clocks for Common View passes at that level.

Nevertheless laser operations are weather dependent and do not allow continuous comparison of remote clocks. This is particularly true in the non Common View mode. Due to the altitude of Jason-2 (of 1335 km), time transfer by laser link over intercontinental distances is limited by the stability of the onboard oscillator (of 10^{-13} over 1000 s) which is based on the DORIS system. On the other hand, T2L2 data provide some accurate information about the behaviour of the frequency bias of the DORIS oscillator along time. We show that the estimation of the frequency variations of the DORIS/Jason-2 oscillator, at least over few days, allowed us to synchronize clocks used in the Satellite Laser Ranging observatories at the level of 1-2 ns.

The present study showed the need of ultra stable reference clock system (as hydrogen maser) to be deployed through the laser ranging network, and the need to accurately determine their time calibration (delays in the cables and electronic devices at ground) at the few ps level.