



## **A method of time transfer between remote stations via LRO**

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Satellite Laser Ranging (SLR) is a standard geodetic technique that uses the round trip time of light from a ground station to a satellite to determine distance. When combined with a spacecraft detector and timing system, this technique can also be used to transfer time between ground stations, demonstrated by the Time Transfer by Laser Link (T2L2) project by the Centre National d'Etudes Spatiales (CNES) and Observatoire de la Côte d'Azur (OCA) as well as the Laser Time Transfer (LTT) project by the Shanghai Astronomical Observatory. We describe an additional method of time transfer using simultaneous one-way laser ranging (LR) by two or more ground stations to the Lunar Reconnaissance Orbiter (LRO). A one way ranging is necessary, as two way ranging via retroreflectors for time transfer becomes impractical at lunar distances. The method will utilize the one-way LR currently being performed as a part of the LRO mission, allowing time transfer to be a by-product of the conventional usage of the data. Each ground station is referenced to a Master Clock using a multifrequency all-view GPS receiver at both the ground station and Master Clock locations. The Master Clock is located close enough to the ground station to make ionospheric differences in signal path negligible. Two or more stations range to LRO at the same time and their times of arrival are compared. Results from a ground-based experiment are shown, with sub-nanosecond precision shown to be achievable. Ultimately this measurement will provide a more precise and accurate relation of timing standards between stations, leading to a marked improvement in orbit determination.