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Framework for Measuring mm-Accurate Local Survey Ties over 1km baselines at the McDonald Geodetic Observatory

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The goal for the next generation of terrestrial reference frames is to combine the observations from multi-technique reference stations and to achieve a 1mm and 0.1mm/yr accurate frame realization. The result would open the door for countless disciplines that rely on high precision GNSS observations for their research. The largest source of error in the terrestrial reference frame realizations is not in the instruments and their measurements but in the ties between the instruments at multi-technique stations determined through local surveying. Local tie surveying is the measurement of the distance between instrument centers and is conducted via electronic distance measurement with total stations or through the collection of GNSS observations. Both techniques are unable to achieve mm-accurate ties, especially over a 1km baseline.

In this paper, we develop a framework for determining the local tie between an SLR station and a VLBI antenna at the McDonald Geodetic Observatory using electronic distance measurement and we compare those results to GNSS observations. We apply and combine the state-of-the-art of existing metrology and surveying technology and techniques to reduce errors. Our instruments are two total stations placed in a braced quadrilateral formation that covers the kilometer baseline between two local control networks formed by semi-permanent monuments, each surrounding either the SLR or VLBI center. Simultaneous ranging is performed along the braced quadrilateral to counter the angular errors due to atmospheric refraction. We apply batch non-linear least squares estimation to the ranges and sets of angles observables to establish the coordinates of the local control networks and thus, determine the tie between the sites. Early results show standard deviation values of under a millimeter in the horizontal and 2-3 millimeters in the vertical. With repeated surveys conducted over the next year, we aim to reduce the errors and standard deviations further and to demonstrate repeatability of the technique to 0.1mm/yr and its consistency with GNSS.