Multistatic Space Surveillance with the Murchison Widefield Array using Passive Radar

Brendan Hennessy[*†], Robert Young[†], Mark Rutten[‡], Steven Tingay[*], Stephen Howard[†], Ashley Summers[†], Daniel Gustainis[†],

[*]International Centre for Radio Astronomy Research (ICRAR), Curtin University

[†]Defence Science and Technology Group

[‡]InTrack Solutions

The Murchison Widefield Array (MWA) radio telescope is an ideal passive radar receiver for wide area surveillance of objects in low Earth orbit (LEO) using FM radio. The MWA is the low-frequency Square Kilometre Array (SKA) precursor and consists of over 8,000 antennas across a large area in the radio quiet Murchison Radio-astronomy Observatory in the Western Australian desert. The array provides significant sensitivity and wide area coverage combined with accurate direction of arrival estimation.

The MWA's location, as well as the typical transmitter radiation patterns, results in the MWA receiving reflections from satellites from transmitters across a large section of the continent. Diversity in transmitter options is crucial to wide area surveillance as it maximises potential illumination coverage in the volume above the MWA as well as minimising reliance on favourable transmissions. Multiple transmitters also enable multistatic detection and processing to make use of the varied geometries.

This presentation details the signal processing, detection, and orbit determination steps required to track satellites in LEO. It highlights the benefits of multistatic detections for the orbit determination step, particularly for rapid trajectory estimation. The presentation also details recent work on coherent multistatic subspace detection potentially enabling greater sensitivity.

This work is highlighted by results from a series of observations with reference collections from a wide range of transmitters including Geraldton, Perth, Albany, Adelaide, and Mt Gambier, representing diverse baseline distances from 300 km through to 3,000 km. These results demonstrate the capabilities of the MWA as a passive radar receiver for the surveillance of space as well as confirming initial predictions for the performance of the system.

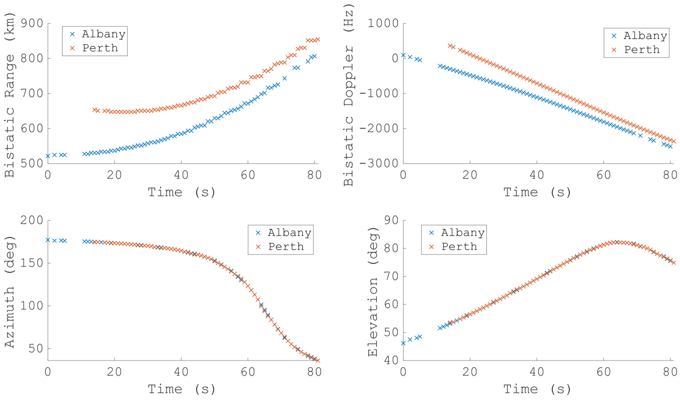

Fig. 1. The four measurement parameters from detections of COSMOS 1707 detected using FM transmitters in both Albany and Perth.

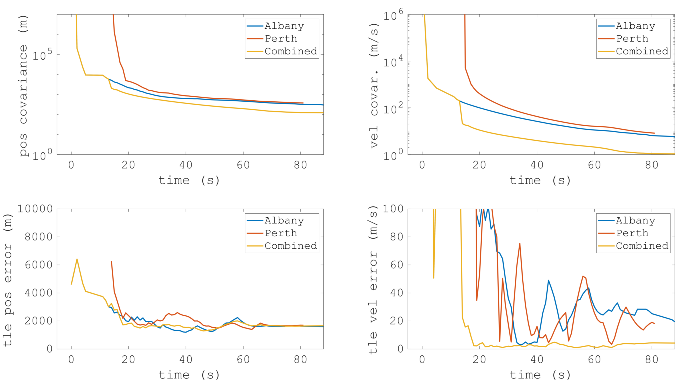

Fig. 2. The resulting orbit predictions from the multistatic measurements from Fig 1. The top panels show the covariance of the position estimate and the velocity estimate. The bottom panels show the mean errors when compared with the TLE.