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UPDATE ON SPACE SITUATIONAL AWARENESS WITH CSIRO RADIO TELESCOPES

Abstract

Australia Telescope National Facility (ATNF) is one of the world's most advanced radio astronomy facilities. Murriyang, our Parkes sixty-four meter radio telescope, Australia Telescope Compact Array (ATCA) on Gomeroi Country, is an array of six twenty-two metre Cassegrain reflector antennas and Mopra radio telescope on Gamilaroi Country is a single twenty-two metre Cassegrain reflector antenna. Though designed for detection of faint radio emissions from astronomical objects they are available for commercial and non-astronomy use, including passive radio frequency surveillance, bi-static radar, and space communication. Previous Space Situational Awareness (SSA) research with ATCA has included interferometric observation of Medium Earth Orbit (MEO) objects and the development of a model for estimating Direction of Arrival (DOA) as well as bistatic Continuous-wave radar (CW radar) observations of space craft and rocket bodies in X-Band. We continue to use this Doppler compensated bistatic configuration to track near earth objects (NEO) with ATCA as part of the Southern Hemisphere Asteroid Radar

Program (SHARP). Recently our research efforts have been directed towards high frequency Ka band bistatic radar observations out to geosynchronous orbit (GEO) 36,000km. This work has presented new challenges with accurately tracking spacecraft, and provides an opportunity to leverage our radioastronomy knowledge and techniques to improve the SSA outcome. At these frequencies large radio astronomy dishes have small beamwidths and there is also a need to consider atmospheric effects at low elevation angles where refraction is sufficient take the spacecraft entirely out of the beam. As a receive only system, Radio Telescopes are well suited to passive RF surveillance to track active objects, refine orbits and characterise emissions. Unintended electromagnetic radiation (UEMR) has been detected several times with our telescopes, both in targeted operations and during routine astronomical observations. A cislunar SSA project has commenced to research passive RF methods of orbit determination. The population of Cislunar spacecraft is increasing with three missions to the Moon already this year. The highly sensitive receivers of the Mopra 22m radio telescope have been utilised to perform preliminary observations of cislunar spacecraft including the Lunar Reconnaissance Orbiter (LRO), the Korean Pathfinder Lunar Orbiter (KPLO) and CAPSTONE. The S and X-band dual polarisation receivers have been used to record RF data from the spacecraft telemetry downlinks to the Deep Space Network. The spacecraft range rate can be estimated from the Doppler shift in the frequency domain. Further research will include using this data to perform orbit determination.