Ground-Based Preparatory Activities (13)
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ENHANCED MOBILE TRACKING SOLUTION FOR ISRO MISSIONS: THE INDIGENOUS 3-AXIS STABILIZED TRANSPORTABLE TERMINAL

Abstract

The Indigenous Transportable Terminal, developed by ISRO's ISTRAC with Indian industry collaboration, advances Telemetry, Tracking and Command (TTC) capabilities for ISRO's increasingly sophisticated space missions, including those with complex launch profiles and human spaceflight. This 4.6-meter S-band transportable antenna terminal addresses the limitations of fixed ground stations by providing a mobile, adaptable solution deployable on both land and sea. This flexibility is crucial for tracking dynamic mission phases, such as satellite separation, which are challenging to monitor with stationary infrastructure.

The terminal is built on a 3-axis stabilized tracking mount (Azimuth, Elevation, and Cross Elevation) that adjusts for pitch, roll, and yaw disturbances, essential for accurate tracking in variable sea and land conditions. Each axis features a dual-drive mechanism to minimize gear backlash, allowing precise pointing and enabling single-motor operation in case of motor failure, ensuring reliable performance. The terminal's high Gain-to-Noise Temperature (G/T) ratio is achieved through a Carbon Fiber Reinforced Polymer (CFRP) reflector with an Axially Displaced Ellipsoid (ADE) geometry feed. Additionally, the terminal is designed to switch easily between S-band and X-band frequencies with minimal hardware modifications, making it versatile for a range of mission requirements.

The transportable terminal is containerized for convenient transport in a standard 40-feet ISO container and is equipped with a motion simulator to emulate sea-state conditions, ensuring operational readiness before deployment. It can operate in multiple modes: Operational Mode, Survival Mode to withstand high wind speeds, and Transportation Mode for safe transit. During performance validation through sea trials and ISRO mission tracking, the terminal demonstrated high pointing accuracy (within 0.2 degrees) and stable tracking performance across diverse conditions.

A key application for this terminal is the Gaganyaan mission, India's first human spaceflight program. Gaganyaan's mission design includes a unique orbit (170 x 400 km with a 51-degree inclination) that poses visibility challenges during critical events, such as Orbital Module (OM) separation, solar panel deployment and de-boost operations. Given the human safety requirements and the need for continuous crew communication, real-time TTC coverage is essential. Current fixed ground stations cannot fully support these requirements, but the transportable terminal addresses this gap by providing reliable, mobile tracking to ensure real-time data for mission-critical phases, which is particularly vital for human-involved missions.

Overall, this indigenous transportable terminal enhances ISTRAC's TTC network, offering greater operational flexibility and reliability for future ISRO missions.