

Indian Regional Navigation Satellite System

Ground Segment

An Invited Talk

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Navigation with Indian Constellation (NavIC) or Indian Regional Navigation Satellite System (IRNSS) is a constellation of seven GEO and GSO satellites along with the associated ground segment, realized by Indian Space Research Organization (ISRO) for providing independent position, navigation and timing (PNT) services over the Indian region and the surrounding area extending up to 1500 km beyond its geographical boundary. The ground segment of NavIC consists of navigation centers linked with a number of one-way and two-way ranging stations and a precise timing facility called the IRNSS Network Timing (IRNWT) facility.

Time plays a crucial role in providing PNT services and a precise timing laboratory is the heart of the NavIC system. The IRNWT is responsible for the generation and dissemination of the IRNSS system time. The system time of IRNSS is being generated through an ensemble of Active Hydrogen Masers and high performance Cesium clocks. A paper clock is generated by combining the phase difference measurements of the participating atomic clocks. The resultant paper clock is physically realized through a digital synthesizer and the output signal so realized is used as the reference time for IRNSS. This time is steered to Coordinated Universal Time (UTC) such that the difference $|\text{IRNWT} - \text{UTC}|$ does not exceed a specified threshold. To ensure traceability to a standard reference such as UTC, time transfer is being carried out with National Physical Laboratory, India (NPLI). Common-view and Two-way Satellite Time and Transfer System (TWSTFT) are the methods used for time transfer.

The one way and the two ranging networks provide the much needed ranging information of the satellites for performing precise orbit determination of the satellites. Laser ranging of the IRNSS satellites is also performed for enabling calibration of the biases. The navigation centers house all the computing networking and software infrastructure to ingest the data in real time and generate the much needed navigation parameters. The navigation centers are linked to all the ranging stations via redundant links. The ground segment in all performs the orbit determination and time synchronization of the IRNSS constellation and ensures that all the required navigation parameters are generated and uplinked to the satellites.

The position and timing accuracy provided by the IRNSS system is very encouraging and a host of applications are on the anvil. This talk shall feature some of the technological challenges that were faced in the establishment of the IRNSS ground segment and their solutions.