PRESS INFORMATION BUREAU
GOVERNMENT OF INDIA
BANGALORE
******

FEATURE

SATELLITES FOR NAVIGATION

G Madhavan Nair**

Position, Navigation and Timing (PNT) through satellites is an important service that has emerged in recent years. Satellite based PNT service is of vital importance to the contemporary world not only for civil aviation but in many other areas such as mobile telephones, surface transport, intelligent highway system, maritime transport, rail, oil and gas, precision agriculture, fisheries, survey and marine engineering, science, electricity networks and leisure.

Of the presently operational satellite systems for navigation, the Global Positioning System (GPS), conceived and developed by the US military, comprising 28 satellites placed in 20,000 km orbit has become very popular because of its myriad of uses in the civilian sector. Though Glonass, the Russian counterpart of GPS, was started with similar objectives, the steady decrease in the number of satellites in the system has reduced its capabilities. Europe is developing Galileo, a constellation of 30 satellites to be placed in 24,000 km which is planned to be operational by 2012. Besides civil aviation, the Galileo system is aimed at providing service to various modes of transport, communications network, intelligent highway systems, personal mobility and vehicle tracking.

Positioning Services

The positioning services offered by the GPS or GLONASS constellations for civil aviation fall short of the accuracy, integrity, availability and continuity of service requirements of air navigation services for landing. Thus, augmentation systems are necessary to the core GPS constellation for enhancing the services provided by this core constellation to meet air navigation requirement for various phases of flight — from enroute to precision approach and landing.

Satellite based Augmentation System (SBAS) is one form of such augmentation system being developed as regional systems for large area coverages. Wide Area Augmentation System (WAAS) of USA, European Geostationary Navigation Overlay Systems (EGNOS) of Europe and MTSAT Satellite Augmentation System (MSAS) of Japan are the three emerging SBAS systems. These systems use navigation payloads on four Geostationary INMARSAT third generation satellites and the core GPS.

Considering the important and critical role that Satellite Based Augmentation Systems (SBAS) will assume in the coming years, India has started preparations to implement and use satellite navigation system. Having acquired rich experience in the design and development of communications, meteorological, remote sensing and scientific satellites in the past, India intends to acquire hands on experience in satellite navigation in a phased manner that would finally culminate in the establishment of Indian Regional Navigational Satellite System (IRNSS).

GAGAN

Already, Indian Space Research Organisation (ISRO) and Airports Authority of India (AAI) are implementing a satellite based navigation system over the Indian air-space for civil aviation, called GAGAN (GPS And Geo Augmented Navigation). The space segment of GAGAN in the form of a dual frequency GPS compatible payload is planned to be flown on India's GSAT-4 satellite in 2007. This will serve the Technology

Demonstration System (TDS) Phase of the proposed navigational satellite system. The ground segment consisting of 8 Indian Reference Stations (INRESs), one Indian Master Control Centre (INMCC), one Indian Land Uplink Station (INLUS) and associated navigation software and communication links has been installed. Preliminary System Acceptance Test (PSAT) has indicated that the position accuracies available are good.

Indigenous Navigation System

The Government has also approved in May 2006, a project to implement an Indian Regional Navigation system (IRNSS) in the next 6-7 years. It will consist of a constellation of seven satellites in geosynchronous orbit and a large ground segment. The entire IRNSS system will be under Indian control. The space segment, ground segment and user receivers will be built in India. The independent, indigenously developed IRNSS is expected to provide an absolute position accuracy of better than 20 meter over India. IRNSS system is expected to provide

- Ø High accuracy real time position, velocity and time for authorised users on a variety of platforms.
- Ø Good accuracy for a single frequency user with the help of Ionospheric corrections.
- Ø All weather operation on a 24 hour basis.

Three of the seven satellites in the IRNSS constellation will be placed in Geostationary Earth Orbit (GEO) and four in Geosynchronous Orbits (GSO) inclined at 29° to the equatorial plane. All the seven satellites will have continuous radio visibility with Indian control stations.

IRNSS satellites are configured around a spacecraft bus which is similar to ISRO's meteorological satellite, Kalpana-1, with a mass of 1,330 kg and its solar panels generating a power of 1,400 Watt. The payload consists of two 40 Watt solid state power amplifiers, clock management and control unit, frequency generation and modulation unit, a navigation processor and signal generation unit and redundant on-board atomic clocks. The S-band navigation signals will be fed to a high performance phased array antenna for the required coverage. The data structure will be 50 bits per second and the super frame is 1,500 bits including the iono-tropo model and clock corrections for improved accuracy and integrity. The signal structure is Code Division Multiple Access (CDMA) with the navigation data spread over the CDMA- ranging codes. Two 20 MHz bands separated by 350 MHz are required fort IRNSS. Since L-band, which is most suitable for IRNSS is overcrowded with the existing and planned Satnav constellations, two separate bands in S-band will be used by IRNSS.

IST Infrastructure

The ground segment of the IRNSS constellation will include a redundant Master Control Centre (MCC), IRNSS Ranging and Integrity Monitoring Stations (IRIM) and IRNSS Telemetry Tracking & Command (TT&C) stations. MCC will estimate and predict the position (ephemeredes) of all IRNSS satellites, calculates integrity, ionospheric corrections, clock corrections and runs the navigation software. The IRIMs receive the data from all IRNSS satellites through one-way ranging and transmit the data to MCC for processing. The TT&C stations perform the ranging, telemetry and command functions, provide clock corrections to the satellite and upload the ionospheric and tropospheric corrections to the constellation. In order to make the IRNSS truly independent, an Indian standard time infrastructure will be established. This time standard, based on ground based hydrogen masers, will have very high short and long time stability.

Technological Challenges

Some of the technological challenges include building, launching and maintenance of satellite constellations, adoption and maintenance of an Atomic Time Standard, establishment of Earth Stations and Master Control Stations, Establishment of critical, safety and verification subsystems, Navigation software written to international standards, user receiver manufacturing and Time transfer technology.

With the implementation of IRNSS, which is technologically challenging, India will take a major step towards providing an infrastructure for provision of PNT services throughout India and the neighboring areas. (PIB Features)

***Secretary, Department of Space, Government of India**

AB/RTS/VN

SS-136/SF-136/10.08.2006