India’s GPS-Aided Geo Augmented Navigation (GAGAN) system was launched by the Civil Aviation Minister Mr Ashok Gajapathi Raju in July 2015. Unlike Geographical Positioning System (GPS), which is comparatively less accurate and used commonly for determining position and time, GAGAN has been designed mainly for airline operations to make it more efficient in terms of reduction of costs.

The system will offer improved efficiency, direct routes, increased fuel savings, approach with vertical guidance at runways, significant cost savings because of the withdrawal of ground aids and reduced workload of flight crew and air traffic controllers.

The GAGAN payload is already operational through GSAT-8 and GSAT-10 satellites. The third GAGAN payload was carried on board GSAT-15, which was launched successfully by the European Ariane 5 VA-227 launch vehicle in the early morning hours of 11 November 2015.

GAGAN’s footprint extends from Africa to Australia. Its ionospheric algorithm known as ISRO GIVE Model-Multi-Layer Data Fusion (IGM-MLDF) has been developed by ISRO. GAGAN, will also provide benefits beyond aviation to many other user applications such as intelligent transportation, maritime, highways, railways, surveying, geodesy, security agencies, telecom industry, personal users of position location applications, etc.

Navigational Support to Railways
The GAGAN system can provide navigational support to the country’s railways. Satellite-generated information can be made available to the railways through space technology-based tools that will provide safety at unmanned level crossings.

At some places the railway tracks are under stress. If water accumulation happens, then based on digital elevation model data, a host of information can be given. Specific information can also be provided for aligning the railway tracks, particularly in mountainous regions, and also identifying tracks which are most stable when going through tunnels.

With the use of GAGAN software system, a train would also know the location of any unmanned level crossing and immediately give a warning signal. As soon as the warning signal is given, the train’s hooter will automatically start when it comes near an unmanned crossing.

GAGAN for Aviation
GAGAN is designed as a substitute for the Instrument Landing System (ILS). The Instrument Landing System (ILS) is an internationally adopted ground-based system for navigating aircrafts for the final approach for landing. GAGAN uses a GPS based Wide Area Augmentation System (WAAS) technology developed by Raytheon for the US Federal Aviation Authority (FAA).

GAGAN will allow the ATC to operate 50 planes in the airspace in the same time frame. It also improves efficiency and increases fuel savings — as planes will have to circle less over the airports. Satellite-generated information can be made available to the railways through space technology-based tools that will provide safety at unmanned level crossings.
WAAS is a ground and space-based network that provides error corrections for GPS signals to yield more precision in all modes of civil aviation. It enables civil aircraft to approach for landing with cloud ceilings as low as 250 ft and visibility as low as 0.75 m. This is compatible with a typical ILS that allows an aircraft to make an instrumented approach with a cloud ceiling as low as 200 ft and visibility as low as 0.50 m.

The main advantage of GAGAN is that unlike ILS, the ground system in the case of GAGAN does not need to be duplicated for each runway. This results in lot of cost savings because the GPS signals, as well as the error corrections, are made available to aircraft for any runway within the network using satellite based communication. In order to use GAGAN, civilian aircrafts will be required to be equipped with a small receiver with multiple antennas.

Using the current ground based ILS system, air traffic control centres can operate two planes in the airspace at the same time. GAGAN will allow the ATC to operate 50 planes in the airspace in the same time frame. It also improves efficiency and increases fuel savings — as planes will have to circle less over the airports — reduces the workload of flight crew and ATC, and allows vertical guidance at runways.

A big benefit GAGAN brings to busy airports like Delhi and Mumbai is that it will reduce the distance between two planes during landing and take-off. Under current guidelines, the distance between two planes should be 18 km. GAGAN can reduce it 360 metres.

**GAGAN System**

The GAGAN system consists of a network of several Indian Navigation Reference Earth Stations (INRES) installed all over the country. These earth stations are precisely surveyed to compare the position determined from GPS satellite signals with the location of the receiver. The observed differentials are then sent to two Indian Navigation Master Control Centres (INMCC) where computer processing extrapolates the data to generate error corrections for GPS signals anywhere within the network.

These corrections are relayed via the Indian Navigation Land Uplink Stations (INLUS) and geostationary satellites to civil aircraft equipped with GAGAN receivers so more precise fixes of their position can be derived from GPS satellite signals. GAGAN provides a 1.5-meter precision accuracy in the horizontal and 2.5-meter in the vertical plane.

A flight Management System (FMS) for GAGAN has been developed. It will help civil aircraft operators to save time and money by optimally managing climb, descent and engine performance parameters of the aircraft.

In ILS, prior approval of Airports Authority of India (AAI) is required for construction of a building more than seven storeys high within 20 km of an airport. However, by using GAGAN instead of ILS, this restriction can be relaxed. This system will help aircraft take a ‘curved approach’ before landing and even take-off. The ‘curved approach’ helps aircraft avoid, with high accuracy, tall buildings in nearby areas.

However, almost all the current navigation systems used in India are radar-based. It may therefore take a long time before GAGAN finds buyers in the civil aviation sector.

All planes that will use the GAGAN navigation system would have to replace the older one with it at a cost of about Rs 2 crore per system. India has a total of about 400 aircraft — which means an overall replacement cost of Rs 800 crore.

However, considering the immense benefits of the GAGAN system a balanced approach will have to be taken for its implementation.

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