IN FOCUS

04 DEC 2014

PERFORMANCE ENHANCEMENT OF SATELLITE NAVIGATION SYSTEMS

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Russia placed the second "new generation" modified GLONASS-K satellite into orbit on 30 Nov 2014, Sunday, from its new Plesetsk launch facility.[i] This satellite joins the 24 GLONASS satellites already in orbit. The new satellite is expected to aid an improvement in performance as well as reliability of the GLONASS system. Since its launch in 1993 GLONASS has suffered several coverage blackouts and its performance is also affected adversely by the absence of ground station over large areas. Russia-US talks to enable setting up of GLONASS ground stations on US territory have failed to lead to success.[ii] The GLONASS system's performance till date and the reliability issues faced by it reinforce the need for other nations to look at alternatives.

Background and Current State

The US initiated its first satellite based navigation system in 1960s. That system called Transit was used in 1964 by Polaris submarines deployed globally for navigation and position assistance.[iii] The Navstar global positioning system (GPS) was proposed in 1973. The first satellites of this system were launched in 1978.[iv] Since then more advanced satellites aimed at greater reliability and performance have continued to be progressively launched to improve system performance. GPS came with the facility for selective blanking of signals over some parts of the earth and also the protection of its most accurate signals for use by the US and its close allies only through a system of coding the signals. Non US / Allied users are hence restricted to what is called the civil coded signals that render accuracy of a few tens and even hundreds of meters unlike the sub ten meter resolution offered by the US military code signals.[v] The Soviet Union initiated its own satellite navigation system, the GLONASS. The break-up of the Soviet Union

delayed this system's operationalization until President Putin of Russia gave it priority in the early 1990s. Since its inception and operationalization GLONASS has suffered from several glitches. There have been at least two outages of the entire GLONASS system for as long as a few minutes at a stretch. Some of these failures have been attributed to software flaws that have been since then rectified. It is quite possible that hostile cyber-attacks could have been a contributory factor in the GLONASS glitches.[vi] The European Union initiated its own independent satellite navigation system called Galileo.[vii] This system is yet to reach operational capability. After seeking full participation in the Galileo system China initiated its own satellite navigation system called Compass / Beidou. This system has reached limited operational capability but is yet to cover the entire globe.[viii]

The brief look at the satellite navigation systems available in the world today leads to the question "why are these needed in the first place?" other modern means of navigation assistance today are inertial navigation systems (INS) and other electronic means including radio beacon / transmitter based systems such as the Soviet era short range radio beacon based navigation system the RSBN. The limitation of gyro drift in INS and limitations of range, vulnerability to jamming etc. lead to requirement for a better navigation system. Satellite navigation overcomes most of the flaws and drawbacks in other systems, hence its need and popularity. For all critical applications including military applications there is need for reliability in terms of navigation signal availability. The selective blanking facility built into the American Navstar GPS makes reliance on this system suspect. In the past the US has stated that this blanking facility will not be used in order to popularise the GPS for civil use, especially in civil aviation.[ix] However, given the possibility that in situations where it sees its national interests involved the selective blanking of signals cannot be ruled out. The GLONASS has been used in multi system receivers to back up the American GPS, including by India. The GLONASS has reliability issues as seen earlier. Thus the search for a reliable and robust accurate navigation system leads to the conclusion that ultimately it is only an indigenous system that can meet India's needs. While China apparently having come to the same conclusion has initiated its Beidou system for global coverage, India has started work on its IRNSS for coverage of Indian territory and extending about 1500 km beyond the limits of Indian territory. The unique and innovative architecture adopted by India allows the desired coverage of 40 degree by 40 degrees in longitude and latitude with use of a mere seven satellites thus reducing the cost and complexity of the system. Reduced complexity should lead to higher

reliability. While the launch of improved GLONASS satellites is noted and it is expected that Indian satellite navigation requirements linked currently to GLONASS should soon have better performance, this should be seen as a stopgap measure until such time as the IRNSS becomes fully operational. At the current time three IRNSS satellites have been placed in orbit and the remainder are expected to join these to complete the constellation in a few months from now.

A Strategy for India

IRNSS is a system that will be entirely within Indian control in that the satellite fabrication, ground stations location, launch facilities etc. will be all with Indian organisations and in Indian territory. Over time development of ship based control station may be pursued if the extension of IRNSS to cover more than the initial 40 degree by 40 degree swath is considered. Such mobile floating ground stations would free India from the need to approach foreign nations for permission to establish ground control stations elsewhere. The Indian utilisation of ""Navstar"" GPS and GLONASS alone and in combination, where each functions as a standby to the other, apart it is possible that in some situations both may be unusable by India. In such a situation in spite of the steady and progressive improvements of both the American GPS and Russia's GLONASS, India should prudently continue development of the IRNSS. Even if IRNSS' initial performance does not match up to what is then available through GPS/GLONASS alone or in their differential usage modes. It is only a totally Indian owned and controlled satellite based navigation system that can provide India Strategic and tactical freedom and effectiveness unfettered by external interference.

Conclusion

America's "Navstar" GPS system and Russia's GLONASS continue to be improved in performance. The Chinese Beidou also is steadily improving in performance parameters. Currently India utilises the GPS as well as GLONASS in isolation and in integrated manner where each acts as the standby to the other. This arrangement should be regarded as a temporary arrangement until the Indian IRNSS is available as only an Indian owned and operated satellite navigation system can provide complete strategic and tactical freedom assured of freedom from system denial of use events.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies (CAPS)

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[i] "Russia Puts Second GLONASS-K Satellite Into Orbit: Defense Ministry", http://www.gpsdaily.com/reports/Russia_Puts_Second_GLONASS_K_Satellite_Into_Orbit_Defense_Ministry_999.html, accessed on 04 Dec 2014.

[ii] "Russia plans to place GLONASS ground stations in China", http://itar-tass.com/en/non-political/732658, accessed on 04 Dec 2014.

[iii] Elizabeth Howell, ""Navstar: GPS Satellite Network"", http://www.space.com/19794-navstar.html, accessed on 04 Dec 2014.

[iv] Ibid

[v] Ibid.

[vi] ""All Russian GLONASS Satellites Fully Functioning After Maintenance"", http://sputniknews.com/russia/20140520/189969551/All-Russian-Glonass-Satellites-Fully-Functioning-After.html, accessed on 04 Dec 2014.

[vii] ""Galileo - What do we want to achieve?"" , http://ec.europa.eu/enterprise/policies/satnav/galileo/index_en.htm, accessed on 04 Dec 2014.

[viii] Dr. Rajeswari Pillai Rajagopalan, ""IRNSS: India's Own Satellite Navigation System"", http://orfonline.org/cms/sites/orfonline/modules/analysis/AnalysisDetail.html?cmaid=53783&mmacmaid=53784, accessed on 04 Dec 2014.

[ix] ""Satellite Navigation - GPS - Presidential Policy", http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/gps/policy/presidential/, accessed on 05 Dec 2014.