Centre for Air Power Studies (CAPS)
Forum for National Security Studies (FNSS)

PROSPECTS FOR INDIAN SPACE TECHNOLOGY

Gp. Capt.Vivek Kapur
Senior Fellow, CAPS

Introduction

India's space program has made great strides since its humble beginnings in the 1960s. In the initial years, it focussed on design and building of simple satellites. In later years, it gained expertise in designing and building very complex ones. Indian Space Research Organisation (ISRO) then moved to reduce its dependence upon foreign space launch facilities through initiation of the indigenous launch vehicle program. Starting with the Satellite Launch Vehicle-3 (SLV3) which could take a mere 40 to 50 kg to low earth orbit (LEO), it has incrementally progressed to the ability to launch heavier satellites on its augmented SLV (ASLV), Polar SLV (PSLV), and Geosynchronous SLV (GSLV) launchers; the latest variant of the GSLV, the GSLV Mk-III, can take up to 5 tons to geosynchronous orbit (GEO).[1] ISRO is reportedly now moving to develop capabilities to reduce the cost to launch payloads to space through development of newer launch technologies. Major Indian newspapers have reported that ISRO plans to test fly its Reusable Launch Vehicle (RLV) in March 2015.[2] It is also reported by the same newspapers that India plans to launch the next two satellites for the Indian Regional Navigation Satellite System (IRRRNSS) this year.[3] All services that require accurate navigation signals in the civil as well as military domains in India currently use the American satellite navigation based Global Positioning System (GPS) or the equivalent Russian Global Navigation Satellite System (GLONASS). Being foreign systems, GPS and GLONASS are subject to the larger interests of the technology owners involved. The ISRO plans made public bode well for India's space technology sector.

Background and Current Status

Like in many other high technology fields, today's rocket science found its first expression through the efforts of German scientists during the mid-twentieth century. Theseinitial efforts were aimed at the use of rocketry in war, but none the less, led to the development and maturing of the basic building blocks upon which most of today's rocket technology is based. After the end of World War-II both the erstwhile Soviet Union and USA utilised captured scientific knowledge from defeated Germany to advance their rocket programs. These efforts led to the Soviet Union, followed by USA, becoming the first nations to achieve space access. Proliferation of rocket technology led to European countries achieving similar capabilities, albeit collectively, followed by China and Japan. Today rocket technology is not as rare as it was earlier. With the basic science fairly widely understood, it is almost just a matter of engineering to put together an effective space launch rocket. The issue today is to design and build reliable rockets that have a high probability of success and to reduce costs of each launch. The Soviet Union's successor state, Russia, today boasts of being the leading spacefaring nation with the highest number of successful space launches.[4] The USA has in the past few years suffered embarrassing technology setbacks that have led to the retirement of the Space shuttle fleet and spectacular failures of its space launch rockets. USA has been reduced to importing rocket engines from Russia to maintain a minimum space launch capability and to book seats on Russian rockets to send astronauts to the International Space Station.[5] In this context China boasts an enviable space launch record second only to Russia in recent years.[6]The development of India's space rocket technology has been written about on this website in detail during 2014. India has a well proven reliable workhorse in the PSLV and its variants. PSLV, however, is able to place relatively lighter payloads of about 2.5 tons into earth orbit. The GSLV variants are aimed at addressing this launch load shortfall. The GSLVs remain in development and are yet to notch up the success rates demonstrated by the PSLVs. ISRO has announced that it now plans to test launch a RLV in March 2015.

The RLV is likely to feature a single stage booster that will lift the vehicle aloft and impart a speed of about Mach 3.0+ to it. At this speed it would rise to an altitude above 100 km. Here it would carry out its mission of satellite release and then re-enter the

atmosphere at high Mach numbers. It would now glide at speeds of up to Mach 5.0 or higher andfinally land like conventional aircraft do on a suitable runway. The RLV could then, through attachment of a new booster stage, be reused, thus reducing costs of a launch through reducing the waste that results from rockets that are a one shot vehicle with the entire vehicle being lost after a launch. At a later date, it may be possible to incorporate a supersonic combustion ramjet (scramjet) engine in the RLV to develop a powered vehicle with other utilisation possibilities. However, the initial RLV concept remains that of an unpowered glider once it detaches from the rocket booster used to launch it from a conventional rocket launch pad. Even the current concept of the initial RLV design is projected to be able to reduce the launch cost of satellites by ISRO by a factor of 10.[7] Ata later stage, ISRO could even emulate the American Space X concept of using a floating platform as a landing pad for the first stage of the RLV launch system.[8] Successful recovery of the booster stage used to launch the RLV could reduce launch cost even further. RLV represents another challenge for ISRO and indicates that the organisation is looking ahead and thinking futuristically about useful technologies for the future.

IRNSS has been written about in detail on this website earlier in 2014. IRNSS is an innovative low cost solution to India's satellite navigation needs in both the civil as well as military sectors. IRNSS can commence operations with just four satellites though the entire seven satellite constellation will increase coverage and accuracy.[9] The system can be scaled up to increase coverage from the initially planned area if required in future. It is expected that the year 2015 will see the IRNSS come on line once the planned satellite launches fructify.

ISRO has notable achievements to its credit in 2014. These include the Mars orbiter Mission (MOM) and the successful tests of the indigenous cryogenic engine and of the heavy lift GSLV Mk-III. Given the track record of ISRO's achievements so far, it is reasonable to be optimistic about ISRO achieving its declared programs for 2015.

Analysis of ISRO Technology Development

ISRO is and remains a purely civil organisation. However, the technology developed by ISRO could, in certain circumstances, be leveraged by the Government for national

security needs as and when this is required. ISRO's satellite developments were initially designed and used for purely civil purposes before being utilised later for a few military applications such as remote sensing satellites being used for surveillance and communications satellites being used for limited military communications through hired transponders. From this point of view, ISRO's achievements till date and future plans bode well for India's national security. A few ISRO programs have parallel effort in the defence domain from Defence Research and Development Organisation (DRDO).[10] One such example is the development of scramjet engines for their own planned applications in the civil and military domains. India's effort to develop scramjet engines and hypersonic vehicles has also been written about on this website in 2014. This is unique to India where the space program was started as, and even today remains, a totally civil effort. In most other countries, including USA, Soviet Union, China etc., the national space programs have a heavy defence tilt with civil uses being a spin off; in India the reverse is true with military applications being a spinoff of the civil space program. India's system though often criticised domestically for this structure, could be said to be actually a better way of doing things. These concurrent civil and military technology development efforts by ISRO and DRDO result in a situation of each serving as a back up to the other. For instance, given that both ISRO and DRDO have achieved stable supersonic combustion in ground tests, at least one of these efforts should result in a working practical scramjet.

Even an unpowered hypersonic glide vehicle has obvious military applications when mated with a ballistic missile. Adding a scramjet to the vehicle only expands the possible uses of such a craft. It would be evident that successful development of a powered hypersonic vehicle could enable the country's aerospace forces to leapfrog an entire generation of aerospace technology to arrive at the state of the art for the next century.

Conclusion

India has had an active space program since the late 1960s. This program has operated purely in the civil domain. In recent years, India's space program has demonstrated its maturity through developing capabilities earlier owned only by technologically advanced countries. More importantly, India has demonstrated its

capabilities through achieving feats that the others were unable to, at a lower cost and with higher success rates. The MOM is an outstanding example of this. Given the achievements till date ISRO's declared plans to test the RLV and put the IRNSS into initial operation during 2015 are expected to add to ISRO's already noteworthy achievements.

(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])

End Notes

[1] "The History of India in Space", **http://www.spacetoday.org/India/IndiaSpaceHistory.html**, accessed on 07 Jan 2015. And "Launchers – Overview",http://www.isro.org/update/18-dec-2014/first-experimental-flight-of-indias-next-generation-launch-vehicle-gslv-mk-iii, accessed on 07 Jan 2014.

[2] Arun Ram, "Another leap in space: India to test reusable vehicle in March", http://timesofindia.indiatimes.com/india/Another-leap-in-space-India-to-test-reusable-vehicle-in-March/articleshow/45770208.cms, accessed on 07 Jan 2014.

[3] "ISRO to launch new satellite IRNSS 1D", http://indiatoday.intoday.in/technology/story/isro-to-launch-new-satellite-irnss-1d/1/411713.html, accessed on 07 Jan 2115.

[4] "Russia Remains World Leader in Space Launches: Roscosmos", http://www.spacedaily.com/reports/Russia_Remains_World_Leader_in_Space_Launches_Roscosmos_999.html, accessed on 07 Jan 2015.

[5] Ken Kremer, "ISS, NASA and US National Security dependent on Russian & Ukrainian Rocketry Amidst Crimean Crisis", http://www.universetoday.com/110006/iss-nasa-and-us-national-security-dependent-on-russian-ukrainian-rocketry-amidst-crimean-crisis/, accessed on 07 Jan 2015.

[6] Paul D. Spudis, "China is now Positioned to Dominate the Moon What are they Up to?",http://www.airspacemag.com/daily-planet/china-now-positioned-dominate-moon-180953267/?no-ist, accessed on 07 Jan 2015.

[7] N2

[8] Jim Algar, "SpaceX Unveils New Floating Rocket Landing Pad", http://www.techtimes.com/articles/21033/20141126/spacex-unveils-new-floating-rocket-landing-pad.htm, accessed on 07 Jan 2015.

[9] N-3

[10] "DRDO working on Scramjet aircraft, says Saraswat", http://www.newindianexpress.com/states/andhra_pradesh/article1440053.ece, accessed on 07 Jan 2015.
