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ISRO MOVES TO ADD TO INDIA'S LAUNCH CAPABILITIES

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Introduction

Indian Space Research Organisation (ISRO) first ventured into developing an indigenous space launch capability in the late 1970s. These efforts initially led to the Satellite Launch Vehicle (SLV)-3 achieving success. SLV-3 had the capability to place a mere 40 kilograms (kg) into low earth orbit and given the fact that most useful satellites of the time weighed as much as ten times that capability, SLV-3 remained a technology demonstration more than a practically useable satellite launch vehicle. Further efforts led to the Augmented SLV or (ASLV) being tested. ASLV boosted the country's satellite launch capability to 150 kg taken to a 400 km altitude circular orbit. The Polar SLV (PSLV) entered its experimental and development phase soon thereafter.

The PSLV, after a series of testing and proving flights, entered its commercial exploitation phase where launches are carried out for those customers willing to pay for launch of their satellites. PSLV has since established an enviable track record of over 33 successive successful commercial satellite launch missions. PSLV's precision in satellite insertion has been well documented over these launches. PSLV has also demonstrated the ability to place several satellites into orbit in a single mission. ISRO saw quite early that for it to meet India's space application needs fully it would require to develop satellite launch capability matching that available in the US, erstwhile USSR, Russia, China, and Europe. Thus, ISRO initiated the Geosynchronous SLV (GSLV) program.

Background and Developments

Several space applications require satellites to be placed in geostationary orbit (GEO). Some such satellites weigh up to 4,000 kg or more. This situation forced India to pay for satellite launches of the heavier and more capable satellites built by it on foreign launchers. ISRO embarked on its endeavour to further boost its launch capability in the 1980s. This endeavour required a cryogenic engine for the upper stage. In order to save time ISRO attempted to import cryogenic engine technology. However, as the attempt to import this technology failed, ISRO went ahead with development of cryogenic engine technology on its own. The first few GSLV launches were carried out with imported Russian cryogenic engines.[1] Once indigenous cryogenic engines were cleared for actual launches, the process of testing these in flight commenced. The first development flight of GSLV Mk-II, on 18 April 2001, placed the satellite GSAT-1 into geosynchronous transfer orbit (GTO). Subsequent flights of GSLV Mk-II were on 08 May 2003, 20 September 2004, 10 July 2006, 02 September 2007, 15 April 2010, 25 December 2010, 05 January 2014, 27 August 2015, and the latest launch on 08 September 2016.[2] These launches were a mixture of developmental and operational flights. Of these, the satellite launched on 10 July 2006 could not be placed in orbit as the rocket had to be destroyed about sixty seconds after launch as its trajectory veered out of permissible limits.[3] The first GSLV flight with the indigenous cryogenic upper stage (CUS), on 15 April 2010, resulted in a failure to insert the satellite into orbit due to issues with the CUS.[4] The next flight on 25 December 2010, the second flight with indigenous CUS, also resulted in failure.[5] These two flights had been planned as development and operational flights respectively. The next flight was the fifth development flight, on 27 August 2015, which was the ninth GSLV launch and the third flight of the indigenous CUS.[6] This mission successfully inserted its satellite into orbit.[7] On 08 Sep 2016, ISRO successfully carried out the tenth GSLV launch lifting the INSAT-3DR satellite weighing 2,211 kg into GTO. The significance of this mission is that it was the first operational mission of the CUS, and INSAT-3DR is the heaviest satellite ever launched aboard an Indian launcher. ISRO has announced that with this launch it is confident of having overcome the initial problems with the CUS engine and is ready to operationalise the indigenous CUS equipped GSLV MK-II launcher.[8] The next step announced by ISRO is that it intends to further boost GSLV to GSLV Mk-III with the new CE-20 indigenous cryogenic engine to enable satellites of up to 5000 kg to be launched to GTO and Geo Stationary Orbit (GEO).[9]

Analysis

The demonstration of enhanced satellite launch capability by ISRO could have several potential benefits for the country.

Till date, India was able to launch satellites of relatively light weight and hence relatively limited dimensions. For putting its heavier satellites into orbit India required to pay for launch slots aboard foreign launch vehicles such as the European Ariane rockets. This resulted in foreign exchange outflow. In addition, launching heavier satellites required interaction with foreign agencies and booking launch slots in advance. This could be detrimental to India's interests especially if there were to be a need to quickly launch a relatively heavy satellite at short notice for national security reasons.

With GSLV MK-II achieving a string of successes and the CUS being proven, India can now launch satellites weighing in the range of 2000 to 2500 kg into orbit on its own. This gives the country greater strategic flexibility and independence from dependence on foreign satellite launch resources. Over time, once the GSLV-MK-II is offered for commercial paid launches, this launcher could become a revenue generator in its own right.

ISRO is reportedly working on the more powerful GSLV MK-III with its CE-20 CUS. This rocket is planned to place satellites weighing up to 5000 kg into orbit. Once GSLV Mk-III enters its operational phase India will have achieved the ability to launch even very heavy payloads into space. Given the successes achieved with GSLV Mk-II it is quite possible that GSLV Mk-III may take a reduced time from its development flights to operationalisation as the technology is likely to be similar, though scaled up in power output for the GSLV Mk-III.

Apart from satellite launch ability the GSLV offers several other potential benefits. It was written on this website in earlier articles that ISRO in 2014 lacked a rocket powerful enough to launch its Mars Orbiter Mission (MOM) to Mars directly. Hence ISRO adopted the option of using a phased approach of placing MOM into earth orbit initially, thereafter progressively increasing its orbital velocity to make the MOM break free of earth's gravity and head towards Mars. GSLV-Mk-II and GSLV Mk-III, to a greater extent, could provide ISRO with the tools to launch deep space missions with greater ease. Moreover, a potential future Indian manned space program would be possible once GSLV-Mk-III with its greater lifting power is available.

ISRO's successful projects of recent months include the Reusable Launch Vehicle – Technology Demonstration (RLV) - (TD) flight in May 2016. More recently, ISRO, as part of its RLV project, successfully tested two scramjet engines in flight.[10] The RLV project offers the potential to reduce launch costs to a tenth of current costs.

This benefit apart, the component technologies of RLV-TD, such as high temperature materials, hypersonic design validation, scramjet engines, etc. could have positive spinoffs for other national security requirements. The GSLV vehicles could play a major role in this enhanced space capability for scientific, commercial, as well as national security requirements.

Conclusion

Since its early steps in the field of developing launch vehicles, ISRO has made great strides. It owns the PSLV rocket which has a world class record of successful launches with high precision of payload insertion into orbit. Its gap in heavy lift capability has been met to an extent by the development and testing of GSLV Mk-II. ISRO further intends to develop the more powerful GSLV Mk-III to further enhance its lift capability. In parallel it is pursuing its RLV project which is primarily aimed at reduction of launch costs. The technologies being developed as part of RLV could have several national security applications as well.

(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])

Notes

[1] Isro.gov.in, "List of GSLV Launches", http://www.isro.gov.in/launchers/list-of-gslv-launches, accessed on 09 September 2016.

[2] Ibid.

[3] "FAQ: 10 Things to Know About GSLV D5", *New Indian Express,* http://www.newindianexpress.com/nation/FAQ-10-Things-to-Know-About-GSLVD5/2014/01/05/article1984161.ece, accessed on September 14, 2016.

[4] Ibid.

[5] N.3

[6] N.3

[7] N.3

[8] Basu, Biman, "India's GSLV Comes Of Age", http://airworldservice.org/english/archives/32922, accessed on September 11, 2016.

[9] Ibid.

[10] Isro.gov.in, "Successful Flight Testing of ISRO's Scramjet Engine Technology Demonstrator", http://www.isro.gov.in/update/28-aug-2016/successful-flight-testing-of-isros-scramjet-engine-technology-demonstrator, accessed on September 14, 2016.