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104 is Not the Only Feather in the ISRO Cap

Abstract

Ever since 15 Feb 17, when the giant PSLV C37 emerged from the thick jungles of Satish Dhawan Space Centre, Sahr, Sriharikota at 0928 AM, lifting off with a thunderous growl, its precious load of 104 satellites and deploying the same precisely in a matter of just 11 minutes, the digital and the print media went into a crazy scramble reporting the exclusivity of the event and complementing the ISRO on the feat. The headlines and breaking news in multiple fora told us repeatedly, that ISRO has not only 'beaten' the previously held Russian record of launching some 37 satellites in one go, but 'shattered' it. This article makes a case, that 104 is not the only feather in the cap of ISRO. There are several other 'world's firsts' that belong to ISRO. The work also takes a look at the subject of satellite support to the defence forces of the country.

The ISRO Saga

In a welcome show of humility, the Indian Space Research Organisation (ISRO) Chairman, Dr A S Kiran Kumar reciprocating to the avalanche of congratulatory messages on the ISRO making history etc. stated, "we are not into the game of making/breaking world records etc., we were just trying to utilise the opportunity that we had, and maximise the returns"¹ Indeed, ISRO has utilised every opportunity to make the nation proud by creating such world class capabilities that not only, have put us in the front ranks of the satellite-faring nations of the world, but also, have given a tangible fillip to our capabilities in the civilian and military domain.

¹ [https:// www.newindianexpress.com](https://www.newindianexpress.com) dt 15 Feb 17



Lets take the 15 Feb launch itself on board the PSLV C 37. The fact is that besides the much reported carriage of 104 satellites, there are some other interesting facts as well:-

- *This first space mission of 2017 had on board, two of its own nano satellites besides 96 from US and one each from Israel (BGUsat), Kazakhstan (Al Farab-1), Netherlands (Peasss), Swiss and UAE (Nayif-1).*
- *The above two indigenous nano satellites were basically in the technology demonstration/exploration mode. The first one, (INS1A) carried the surface bi-directional reflectance distribution function radiometer which will precisely measure the bi-directional reflectance and polarisation distribution functions of various types of planetary material from the ultraviolet (UV) to the near Infrared (310-4800nm). Such cosmic data would aid R&D for the future missions in many areas.²*
- *The second nano satellite (INS1B) carried an equipment called the Earth Exosphere Lyman Alpha Analyser. This is an electro-optics system payload that will register terrestrial neutral atomic hydrogen alpha particles in the earth's exo-atmospheric region for ISRO's R&D and in aiding future missions.*
- *The four stage rocket of PSLV 37, after starting the launch of Cartosat 2 at 17 mins 29 secs when at 510.3 km of its journey, followed it up with the launch of INS-1A and INS 1-B at 17 mins 39 secs and 17 mins 40 secs respectively. In less than a minute thereafter, it embarked on an awe-inspiring feat of launching the balance of 101 satellites in a time period of just 10 minutes and 10 secs (starting at 18 mins 32 secs and finishing at 28 mins 42 secs of its flight) with not a single collision or mal-placement!*
- *For the above launch, the 101 nano satellites (weight range 1.7 to 4.7 kgs) were prepared in quadrapacks of four satellites each . These 25 packs were released in 28 intervals of 4-12 secs. This is a feat unprecedented in the world till date.³*

² <https://osapublishing.org/bi-directional-reflectance-distribution-radiometers>

³ <https://www.ndtvnews.com> dated 15 Feb 17



Let us now bring to light some other ISRO firsts:-

- *The INSAT (Indian National Satellite) series - viz, INSAT 1A, 1B, 1C and 1D in multi-purpose geostationary satellites category with functional areas in tele-communications, broadcasting, meteorology and search and rescue - is the largest domestic communication satellite series in the entire Asia Pacific region, providing lifeline support to the Directorates of Space (DoS), telecom, and meteorology, besides the Doordarshan and All India Radio.*
- *The Indian Remote Sensing Satellite (IRS) series of 11 satellites built, launched and maintained by ISRO and dedicated to earth observation, is the largest constellation of remote sensing satellites in the world today that is being orbited for civilian use.*
- *It is a common knowledge that ISRO (read India) became the first nation in the world to have achieved success in the very first attempt to enter the Mars orbit through its Mars Orbiter Mission (MoM).*
- *In the navigational field, the seven satellite bus of the Indian Regional Navigation Satellite System or IRNSS (3 in geo-stationary and 4 in Geo-synchronous orbit) have had a fabulous launch regime, all in a matter of three years (IRNSS 1A-Jul 2013, 1B-Apr 2014, 1C-Oct 2014, 1D-Mar 2015, 1E-Jan 2016, 1F- Mar 2016 and 1G- Apr 2016). Thanks to IRNSS today, India has its own Standard Positioning System (SPS) with its coverage extending up to 1500 km from India's boundaries with an accuracy of less than 20 m.*
- *The GAGAN (GPS Aided Geo-Augmented Navigation), as a part of Space Based Augmentation System (SBAS), having provided eight Indian Reference Systems (INRES), has already become a lifeline for our Air Traffic Management.*
- *Way back in the eighties, the ISRO has also been credited for the discovery of three species of bacteria in the upper stratosphere (27-41 km) region. One of these,*



named 'Bacillus Aryabhat', honours the name of Aryabhata (the 5th Century Indian astronomer and mathematician; another is named after an astronaut, Bacillus Jan Bector Hoylei). These bacteria have significant impact on cosmic radiations ⁴

Satellite Support to the Armed Forces

Actually there is no separate need to recount the support of ISRO for the armed forces, as the later only makes use of some of the capabilities developed by ISRO with a national perspective. That said, some salient points under the subject are enumerated below:-

- *Towards the start of the journey (late seventies early eighties) the armed forces looked at satellite support only as spin-off benefits emanating from the ISRO's assets already in orbit. For instance, it was the Project Director of Satellite Launch Vehicle - 3 (SLV-3), the illustrious Dr APJ Kalam, who brought the solid fuel technology to the Integrated Guided Missile Development Programme (IGMDP) and used it successfully in Agni Missile for the first time. Similarly, spin off benefits were utilised from the INSAT and the IRS series.*
- *As time passed, the requirement of dedicated satellite support gradually presented itself as the new felt need for the Services. To this end, GSAT 7 (INSAT 4F - Rukmini) became the first geo-stationary satellite (launched in Aug 13) dedicated to the communication and the surveillance needs of the Indian Navy. This multi-band military communication satellite provides our Navy the blue water capability by providing secure and real time communications and networking support ⁵*
- *It may be of interest to note that in the Theatre Level Readiness and Operational Exercise, TROPEX conducted in the Bay of Bengal in 2014, GSAT 7 networked some 60 ships and 75 aircrafts in one seamless loop with a 2000 nm footprint in the Indian Ocean Region (IOR) ⁶*
- *With the launch of GSAT 6 on 27 Aug 2015, the Services got another dedicated military communication satellite. This satellite is capable of providing dedicated support in the areas of Defence communication, surveillance, observation and positioning thus facilitating Net Centric Warfare. (NCW). Equipped with the latest cryogenic engine stage, it features an*

⁴ <https://www.ncbi.nlm.nih.gov.in>

⁵ <https://www.m.timesofindia>india's-first-defence-satellite-GSAT-7>

⁶ <https://www.pib.nic.in>TROPEX2014>



incredibly small and un-furlable antenna of only 6 m. This S-Band antenna can launch five spot beams on the Indian mainland at the same time using frequency re-use scheme with optimum spectrum utilisation effect producing sub-meter accuracies⁷

- *Making their beginning as the technology experimentation satellites (TES), the Cartographic Series (1,2,2A,2B,2C and 2D that went off on 15 Feb 17) have come a long way. These remote sensing satellites with sub-meter resolution actually are dual purpose. Some of their capabilities are :-*
 - *Cartosat 2 features the state-of-the-art Pan Camera with a swath of 9.6 km and a resolution of 80 cm (this is about the world's best capability). The satellite can be steered about 45 degrees along and across the track and is capable of providing scene-specific spot imagery⁸*
 - *Cartosat 2A is dedicated to the Indian armed forces providing accurate imaging of very high precision. It is capable of sending black and white pictures in the visual region of the electromagnetic spectrum⁹*
 - *Much has been said in the open source about Cartosat 2C. It has an incredible resolution of 65 cm; the best in the world today. Launched on the solstice day of 22 Jun 2016, the satellite with this resolution, is capable enough to accurately count the number cars in the parking lot from as far as 562 km in the space. It circles around the world every 90 mins. Another very amazing feature of this satellite is its capability to make one minute videos focussing on one single point. Imagine a satellite dashing at a speed of 37 km in a single second and taking a one minute video of a single point of interest with a resolution accuracy of 65 cm. This is a huge, huge capability which is a great enabler for the armed forces. Truly incredible^{10,11}*
- *The other enabling series of the satellites are the Radar Imaging Satellites (RISAT I and RISAT II). Their signature feature is the Synthetic Aperture Radar (SAR) with a resolution of less than one meter. Such satellites are into a host of multiple missions like tracking hostile ships at sea, carrying out earth observation, flood and cyclone warning and real time monitoring, search and rescue, disaster management and more.*

⁷ <https://www.isro.gov.in>spacecraft>GSAT6>

⁸ <https://www.isro.gov.in>cartosat2>

⁹ <https://www.en.m.wikipedia.org>Cartosat 2A>

¹⁰ https://www.space.skyrocket.de>doc_sdat>cartosat2C

¹¹ <https://www.indianexpress.com>cartosat2c-to-boost-military-surveillance-capabilities>



On Optimal Resource Utilisation

Creating a capability is only one side of the coin, the other, and more important is the arrangement that needs to be put into place to ensure that the said capability is most optimally utilised by multiple users. This is true, not only for the armed forces but also, for the entire spectrum of users. Following points are stated in this context in so far these relate to the armed forces:-

- As per open source, there is an Integrated Space Cell at the Headquarters Integrated Defence Staff (HQ IDS) which is responsible for ensuring the optimal utilisation of the country's space based assets for military use. The cell was established in June 2010 and is jointly operated with the reps of all the three Services besides Department of Space (DoS) and the ISRO¹²*
- The Cell not only looks into the utilisation angle but also, at the threat to our space based assets and security needs thereof. In fact, on date of the announcement of the cell, the then Defence Minister Mr Anthony, stated that the reason for establishing such a cell is because of the growing threat to India's space based assets from counter space systems and anti-satellite systems.¹³*

Following points are stated out of experience as regards the operation of the above said cell^{14,15,16} :-

- There is a need to cumulate rather than differentiate. By that it is implied that the Services' demand should be requirement-driven and not satellite driven. In other words, instead for asking for a dedicated satellite, it will be prudent to ask for specific requirement. ISRO has tremendous capability cumulated on board its multiple space assets. Only a part sharing can meet the entire Services requirement. Every time, asking for a dedicated satellite will amount to great underutilisation besides a gross waste of national resources.*
- In the above context it is heartening to note that the Defence Technology Roadmap for India has clearly stated the space-based requirements of the forces in imaging and communication and forms a part of India's Space Vision 2025.*
- While the utilisation end of the requirement is getting to addressed in a joint manner, the threat angle must always remain on the forefront. In that, it will*

¹² <https://www.>

¹³ <https://www.wikiwand.com>integrated-space-cell>

¹⁴ <https://www.thespacereview.com>renewing-india's-space-vision-a-necessity.>

¹⁵ <https://www.slideshare.net>space-vision-ind>

¹⁶ <https://www.en.m.wikipedia.org>2007-chinese-asat-test>



be prudent to remember the active threat from spy satellites and anti-satellite systems besides the man-made threat from space debris.

- *It makes operational sense to remember that the Anti Satellite Test (ASAT) conducted by China way back on 11 Jan 2007 when a kinetic kill vehicle destroyed an ageing weather satellite FY 1C in the polar orbit is now 10 years into history. Extrapolating this capability growth cycle on one full decade of the time-line, it will be a matter of critical operational analysis to examine what capability our northern neighbour may now possess in this field.*
- *Making a switch from the Ballistic Missile Defence (BMD) capability into the ASAT capability is a 'logical progression'.*
- *ASAT deterrence can only be built by comparable ASAT capability as a progression from our current BMD foot print.*

Way to Go

A glance at the future plans of ISRO make one feel proud; really very proud about this enabling jewel in our crown. A snapshot of some future projects:-

- *Development of new generation of Earth Observation satellites with larger swaths and minimalistic resolutions.*
- *Development of new launch vehicles which will be reusable; also the development of Unified Launch Vehicles (combining PSLV and GSLV).*
- *On 28 Dec this year ISRO is all set to launch world's first rocket with three rovers to moon . (two from Japan and one for Team Indus) ¹⁷*
- *Work on GSLV Mk III - D1 is on with a planned payload of GSAT 19 E. This satellite will carry a KA and KU band payload and a Geostationary Radiation Spectrometer (GRASP) to monitor and study the nature of charged particles and the influence of space radiation on space crafts and electronic components. This launch which is planned in the first quarter of 2017 will make*

¹⁷ <https://www.timesofindia.indiatimes.com/isro-to-launch-world's-first-rocket-with-three-rovers>.



us self-sufficient in launching 3200 kg class of satellites¹⁸

- *Future satellites include GSAT 9, 11, 17, 19, GISAT-1, and the SAARC and NISAR satellites (the NASA-ISRO satellite for remote sensing and radar imaging).*
- *Subject to funding, future extra-terrestrial missions include the following:-*
 - *Moon - Chandrayan II/ GSLV MkII/2018 (mission - human to moon).*¹⁹
 - *Sun - Aditya-1 /PSLV XL/2019 (mission to study the sun).*²⁰
 - *Venus - Indian Venus Orbital Mission / PSLV XL/ 2020 (mission - to study the atmosphere of Venus).*²¹
 - *Mars- Mangalyan II/ GSLV III/ 2018 (Mission- Mars Orbiter with a lander and a rover).*²²
 - *Jupiter - To be decided/GSLV III/2020.*

The caption of this work, '104 is not the only feather thus finds its place.

¹⁸ <https://www.isro.gov.in>gslv MkIII D1/GSAT-19-ISRO>

¹⁹ <https://www.quora.com>what-is-isro-next-project?>

²⁰ <https://www.isro.gov.in>aditya-11-first-indian-mission-to-study-the-sun>

²¹ <https://www.en.m.wikipedia.org>indian-venusian-orbiter-missio>

²² <https://www.swarajyamag.com>mangalyan 2>



About VIF

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