



Space Alert

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ISRO and Satellite Launching Services

Ajey Lele

India's Polar Satellite Vehicle PSLV-C42 on 16 September 2018, successfully delivered two satellites into the low earth orbit. M/s Surrey Satellite Technologies Limited (SSTL), United Kingdom is the owner of both these satellites. The total weight of both these satellites is 889kg. These two satellites named as NovaSAR and S1-4 are expected to provide assistance for forest mapping, land use & ice cover monitoring, flood & disaster monitoring. They would also assist in surveying resources, monitoring environment in general and disasters in particular. They are also expected to play an important role towards providing inputs for efficient urban management.

This mission launched by the Indian Space research organisation (ISRO) had no Indian payload board and was launched under the commercial arrangement with Antrix Corporation Limited. Over the years, Antrix Corporation has been found attracting various foreign customers who are keen to rent the satellite launch services by ISRO. Till date, ISRO has launched 239 satellites, including the two launched recently for the foreign customer. ISRO is in commercial launch business since 1999.

However, majority of the commercial launch missions conducted by ISRO for small, micro and nano satellites have been along with the Indian payloads. All these small satellites have travelled as a pick-back to the main mission. Before PSLV-C42 mission, ISRO has launched on five missions which were exclusively commercial missions for foreign customers. These missions have been for Italy, Israel and Singapore and two launches for France (SPOT 6 and SPOT 7 satellites).

Few decades back, having understood the commercial utility of its expertise, ISRO established its commercial arm M/S Antrix Corporation Limited, during September 1992. This is a private limited company, owned by Government of India with a mandate to market ISRO's expertise in various fields of space technologies. This company is authorised to sale ISRO's products and offer technical consultancy services. Another important aspect of Antrix's mandate involves the transfer of technologies developed by ISRO.

They are to facilitate development of space related industrial ecosystem in India. The satellite launches provided by Antrix gets wider publicity however, it constitutes only as a part of Antrix's overall business. For the fiscal 2017-18, of Antrix's Rs 21 billion turnover, the launch services contributed Rs 2.5 billion. However, the demand is increasing and Antrix has an order book of Rs 9.80 billion, with Rs 5 billion-6 billion contracts in pipeline for launch services in the fiscal 2018-19 and 2019-2020.

For all these years Antrix has been managing their business interests particularly in the area of launch services by fully utilising the 'spare capacity' available with various launches undertaken by ISRO. Such launches are usually meant for the purposes of launching of remote sensing, earth observation (EO) and weather satellites.

However, now over the years, ISRO's clientele has been increasing rapidly. Between the years 1999-2014, on an average ISRO has launched 2 to 7 satellites per year for its clients (maximum of 9 satellites during 2008, there were no launches for foreign customers during 2002-2006). However, during 2015 and 16 on an average 20 satellites per year were launched. This figure shot to 129 in year 2017 and in 2018, till date 30 satellites have been launched as commercial missions. India's

client base also has been almost evenly distributed across the world. So far, ISRO has launched satellites for both space-faring nations and others. Amongst space-faring states, ISRO has launched satellites for Japan, South Korea, Israel, USA and states like Germany, France, Belgium, Italy, Austria etc which are under the European Space Agency (ESA). Other non-space-faring states include, states like Canada, Turkey, Finland, Slovakia, Algeria and few more.

There are multiple reasons why India is emerging as a better option for all these states and particularly for the space-faring states. The obvious reasons include, reliability of India's launch vehicle and the cost factor. In addition, there are not many agencies in the world which launch small satellites regularly. Particularly, smaller states which want to make their presence felt in the outer space, but are not in position to afford big satellites, find ISRO's vehicle as a best option to launch small satellites. Also, requirement for small satellites is increasing day by day particularly from the point of view of internet service providers.

Hence, various private agencies are also getting attracted towards ISRO's facilities. ISRO also has geography to their advantage, being close to equator it can carry more weight. States like Israel prefer ISRO as an option, because their own geography is not favouring them. They have both, technical as well as political challenges. Many satellite launching agencies prefer eastward launching of satellites to gain a boost from the Earth's rotational speed. However, Shavit, the launch system of Israel, undertake westward launches (retrograde orbit) over the Mediterranean Sea. This is mainly because in case of any mishap during launch phase, the debris is likely to fall either on them or in the states in their close vicinity, particularly Iran. The westward

launches also demands compromise with the payload.

For many years, PSLV, the medium lift launch vehicle is playing a very crucial role towards the overall success of ISRO. The first mission of PSLV during 1993 was a failure. The success story of PSLV begins with its second mission (1994) and till date out of total 44 missions, 42 missions have been successful. During last few years, ISRO has started realising that their orderbook is going to remain 'oversubscribed' at least, for next couple of years. Hence, they would have to significantly divert their attention to cater for the increasing commercial demand.

However, the core job for ISRO is research as their name suggests and they are not to go 'full-throttle' commercially. The mandate for ISRO since its inception has been to design, develop and implement various space programmes, for socioeconomic development of the Indian state. Even today, ISRO continues to abide by this mandate. In 21st century, they also have an additional mandate to cater for the defence sector. All this has led to the idea of privatising the PSLV services.

Antrix Corporation realises that, there's big money in 'private space' with the global space business being worth \$330 billion (Rs 23 lakh crore) and showing minimum 2 to 3% of annual growth prospects. There is a major demand for the launch of small satellites and Indian private agencies needs to play a major role in this regard. ISRO is proposing for the direct involvement of the Indian industry in the Small Satellite Launch Vehicle (SSLV) programme for making smaller rockets. In fact, for last few years ISRO has already started the process of engagement with the Indian private industry, so that shortly PSLV launches for the commercial purposes would be undertaken by them.

It is expected that in near future around 50-60 SSLV launches per year would be required to cater for the global demand. Obviously, the existing infrastructure with ISRO would not be sufficient for all these activities. The most critical need would be to develop an additional launch pad for SSLV.

ISRO is aware that the estimates for small satellites market has been projected to be \$18 billion (Rs 1.27 trillion) over the next 10 years. If all goes well, then Antrix and Indian private industry, should be in a position to have a slice of this market, which could be around Rs 1,500-2,000 crore (Rs 15 billion-Rs16 billion) per year. Today, there is an opportunity for Indian private industry, to make it big in the business of space.

Gp. Capt. Ajey Lele (retd.) is a Senior Fellow at the Institute for Defence Studies and Analyses, New Delhi.

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Brief of UN Space Security Dialogues

Daniel Porras

This year has seen significant achievements in the field of space security, with three separate initiatives holding meaningful and constructive dialogues. Together, these discussions represent parallel opportunities to address growing space security threats at multiple levels, including voluntary measures and legally-binding ones.

First, under a Resolution entitled “Further practical measures for the prevention of an arms race in outer space”, adopted by the General Assembly on 24 December 2017, a Group of Governmental Experts (GGE) was convened in Geneva. This GGE, which met from 6 to 17 August 2018, was asked to “consider and make recommendations on substantial elements of an international legally binding instrument on the prevention of an arms race in outer space, including, inter alia, on the prevention of the placement of weapons in outer space.” The GGE met and is already preparing for its next steps.

- An open ended intersessional consultative meeting will be held in New York on 30 January and 1 February 2019. The Chairman of the GGE, H.E. Mr. Guilherme de Aguiar PATRIOTA, Permanent Representative of Brazil to the CD, will make an interim report available to the public sometime in January 2019 and will invite comments at that meeting.
- The GGE will meet for its second two-week session from 18 to 29 March 2019. A Final Report is to be adopted by consensus at that meeting.

Second, the Conference on Disarmament (CD), through CD Decision 2119, established five subsidiary bodies to look at individual CD

Agenda items. The purpose of this approach was to be able to discuss individual topics despite not having an overall work programme. Accordingly, Subsidiary Body 3 was asked to review the Prevention of an Arms Race in Outer Space (PAROS). Under CD Decision 2126, H.E. Mr. Guilherme de Aguiar PATRIOTA, was also nominated and appointed as Coordinator of Subsidiary Body 3 (SB3). SB3 met over the course of six sessions, the last of them being on 26 August.

- The Chair of Subsidiary Body 3 submitted a consensus report to the CD. While the CD was unable to adopt a Final Report, it was able to adopt a Procedural Report, which will include “as appendixes all official documents of the Conference on Disarmament, summary records, process verbal, and reports of subsidiary bodies.”

And finally, the UN Disarmament Commission Working Group II will be meeting in April 2019 to continue their discussions on the practical implementation of the recommendations contained in the 2013 Report of the GGE on Space TCBMs. The UNDC expects to make some recommendations on how the 2013 Report can be effectively operationalized, whether through unilateral, bilateral or multilateral efforts. These discussions are also focused on “voluntary” TCBMs, as this was the nature of the recommendations made in 2013.

It is as yet unclear whether the CD Subsidiary Bodies will meet again, but the GGE on PAROS and the UNDC will continue their efforts in Spring 2019. Both of these efforts are aimed at distinct classes of solutions, namely that the GGE is looking at a legally binding instrument while the UNDC considers voluntary measures.

In other words, the GGE could be looking at a long-term solution, which could take years to

work out, while the UNDC considers short-term methods that could be employed whilst a treaty is negotiated. Together, these two dialogues could pave the way for strengthening stability in space through multilateral dialogues.

Daniel Porras is Space Security Fellow at the UN Institute for Disarmament Research (UNIDIR).

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A Review of Recent Collaborative Efforts between India and France in Space Activities

Narayan Prasad

India and France share a unique and historical partnership in the peaceful uses of outer space in which cooperation and collaboration has been a hallmark between the two countries as they have emerged as important space faring nations. The Indo-French relationship in space is spread over the last five decades different facets of space science, technology and applications, including sounding rocket development, liquid engine development, hosting of payloads, joint satellite realization, training programs, satellite communications experiment and satellite launches.

During the March 2018 visit of French President Emmanuel Macron's India, a renewed framework for cooperation was signed to enable and guide the future direction of bilateral strategic partnership in this area, India and France have agreed on this Joint Vision for Space Cooperation. Some of the key areas of cooperation that shall make a mark in the near future include

Human Spaceflight

With the 2022 target set by Prime Minister Narendra Modi for the first exclusively Indian human space flight, ISRO is on a clock to establish all relevant technologies and gain confidence in assuring mission success. CNES has a long-standing history in human spaceflight and has offered to collaborate in the areas of space medicine, astronaut health monitoring, life support, radiation protection, space debris protection and personal hygiene systems.

The Centre for the Development of Microgravity Applications and Space Operations (CADMOS) or the Institute for

Space Medicine and Physiology (MEDES) space clinic may be used for training of future Indian astronauts, as well as exchange of specialist personnel.

Maritime Surveillance

The Indian Ocean is a region critical to the strategic interests to India and has been witnessing increasing Chinese presence. ISRO and CNES are working towards possibly establishing constellation of new satellites for maritime awareness with 8-10 satellites as part of a constellation for maritime surveillance. The two space agencies are expected to work together for design and development of joint products and techniques, including those involving Automatic Identification System (AIS), to monitor and protect assets in land and sea.

Space Science and Exploration

Over the last decade ISRO and CNES have worked on joint satellite missions for remote sensing with interest in phenomenon affecting the Earth which have led to the realisation of missions such as SARAL and AITiKa. Now the two space agencies intend to expand cooperation to work together on space science and exploration missions. The cooperation in space science and exploration may include autonomous navigation of rovers on Moon, Mars, and other planets, and aero-braking technologies for planetary exploration.

CNES could provide support to ISRO for the navigation of future moon rovers while the two will jointly work on the models to study Mars and Venus atmospheres. The President CNES in his recent visit to India mentioned that the cooperation may move towards CNES being involved in definition of the scientific goals and preparatory studies for the future planetary missions of ISRO and both agencies will study the possibility of embarking French science instruments on board the future

interplanetary (Moon, Mars, and asteroids) Indian mission.

Climate Change

Climate change has been one of the key focus areas for CNES and also is now featuring as a part of the bilateral ties between India and France. CNES and ISRO intend to study the ocean from space using altimetry system and in promoting maximum use of the French ARGOS Data Collecting System. A joint mission Oceansat3-Argos is planned where an ISRO satellite hosting Argos-4 Payload from CNES can utilize radar altimetry by satellite to measure, globally over the oceans, the sea level needed to understand ocean circulation and its variability. Oceansat-3 is likely to be launched this year to provide continuity of data for already established services in the area of oceanographic applications.

Trishna, a satellite for land Infrared monitoring is in the phase of mission definition to combine a high spatial resolution (50m) and high revisit capacities (about 3 days) in the Thermal Infrared (TIR) with global coverage with an intent of monitoring of energy and water budgets of the continental biosphere and the monitoring of coastal and continental waters.

Space Transportation Systems

Taking forward the cooperation in space transportation systems, ISRO and CNES intend to collaborate on the development of technologies for Liquid Oxygen-methane propulsion engine, reusable launch vehicle (including common experiments on RLV) and special materials, nano-materials, advanced composites, polymers, chemicals, nanotechnologies and manufacturing technologies.

Utilization of Ariane by India

With the existing gaps in fully operationalising and possibly serial production of the Geosynchronous Satellite Launch Vehicle (GSLV), ISRO will continue to rely on Arianespace for getting some of India's heavy satellites in the geostationary orbit. The partnership between ISRO and Ariane going back to over 5 decades, Arianespace is set to launch GSAT-11 on 30 November, followed by GSAT-31 in December and GSAT-30 in May 2019.

France has been a long-standing partner for India in space and intends to further strengthen its cooperation in space with India. There is now room to also take advantage of the emerging NewSpace ecosystem in France and India to develop ties in the realm of NewSpace for establish strong economic ties in space as well.

Narayan Prasad is an Associate Fellow at the European Space Policy Institute working towards establishing a vibrant cooperation between India and Europe in space activities. He can be reached on narayan.prasad@espi.or.at

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FROM THE MEDIA

Isro ropes in pvt firms, inks pact with a consortium to assemble satellites

This will be the first set of agreements signed by Isro, which is trying to rope in private partners to overcome its own constraints. The space agency is encouraging private players to form a small consortium to undertake satellite and rocket manufacturing work so that it can remain focused on research and development.

Source: [Business Standard](#), July 18, 2018

Soon, desi solar cells to power satellites in space

This will be the first set of agreements signed by Isro, which is trying to rope in private partners to overcome its own constraints. The space agency is encouraging private players to form a small consortium to undertake satellite and rocket manufacturing work so that it can remain focused on research and development.

Source: [Economic Times](#), July 23, 2018

U.S. would need a mega-constellation to counter China's hypersonic weapons

The Pentagon admittedly is already five to 10 years behind in the development of an anti-missile system to thwart advanced hypersonic weapons that are now being tested by China and Russia. The only way to provide global coverage and not go bankrupt installing radars on the ground is to go to space.

Source: [Space News](#), August 8, 2018

Chandrayaan-2 Lander to be named 'Vikram' after Sarabhai

The lander on the Chandrayaan-2 mission, which is scheduled to be launched early next year, will be named 'Vikram' after Vikram Sarabhai, the father of Indian space programme. "We are also going to set up Sarabhai chairs at the MIT, Cambridge University and Gujarat University.

Source: [Times of India](#), August 12, 2018

Proposed standard seeks to offer more launch flexibility for smallsats

A proposed standard announced at a conference last week seeks to provide the same launch flexibility for larger smallsats currently enjoyed by cubesats. The Launch Unit, or Launch-U, standard announced by the Aerospace Corporation Aug. 6 defines a physical standard for spacecraft weighing dozens of kilograms to make it easier to shift such spacecraft from one launch opportunity to another.

Source: [Space News](#), August 16, 2018

Pentagon report: China's space program 'continues to mature rapidly'

China's continued investments and efforts in space technology are a major concern for the Pentagon, the report says. Chinese strategists regard the ability to use space-based systems — and to deny them to adversaries — as "central to modern warfare."

Source: [Space News](#), August 20, 2018

ESA's leader gets extra time for his vision of European space

That future contains a number of questions, from the fate of the International Space Station

and planning for a return to the moon to emerging challenges like reusable launch vehicles and growing concerns about the safety of the space environment.

Source: [Space News](#), September 28, 2018

Satellite Startup Swarm Is Back Online After Defying U.S. Officials

Last Friday, Swarm received permission from the FCC to reactivate its satellites. The reprieve is temporary and bars commercial use. But Swarm now hopes it can get 100 satellites, called SpaceBees, into orbit by the end of next year and build the cheapest space-based data network of all time. “We’re sort of making a 1996 version of the internet,” says Sara Spangelo, co-founder and chief executive officer of Swarm.

Source: [Bloomberg](#), August 30, 2018

ISRO's Antrix eyes Rs 1,500-2,000cr revenue from small satellite launchers

With the development of Small Satellite Launch Vehicle by the Indian Space Research Organisation nearing completion, Antrix - ISRO’s commercial arm - is targeting to generate revenue to the tune of Rs 1,500 - 2,000 crore per year by providing launch services with the vehicle. The SSLV, which will be ready for the market around the middle of 2019, will be able to carry satellites weighing upto 500 kgs and place them in Low Earth orbit (LEO).

Source: [New Indian Express](#), August 31, 2018

SpaceX signs up Japanese billionaire for circumlunar BFR flight

In an announcement at SpaceX’s headquarters in Hawthorne, California, SpaceX Chief Executive Elon Musk announced the first private customer for its Big Falcon Rocket

(BFR) system will be Yusaku Maezawa, a 42-year-old former musician who founded Zozotown, a Japanese online fashion retail site.

Source: [Space News](#), September 17, 2018

ISRO Technology Incubation Centre inaugurated at NIT Agartala

Tripura Chief Minister Biplab Kumar Deb inaugurated ISRO’s first Space Technology Incubation Centre at the National Institute of Technology Agartala via remote from Bengaluru. The Centre was launched at the first edition of ‘Spacetrronics’ organised by the India Electronics and Semiconductor Association (IESA).

Source: [Indian Express](#), September 18, 2018

Isro to launch 18 missions in next six months

With the development of Small Satellite Launch Vehicle by the Indian Space Research Organisation nearing completion, Antrix - ISRO’s commercial arm - is targeting to generate revenue to the tune of Rs 1,500 - 2,000 crore per year by providing launch services with the vehicle. The SSLV, which will be ready for the market around the middle of 2019, will be able to carry satellites weighing upto 500 kgs and place them in Low Earth orbit (LEO).

Source: [New Indian Express](#), August 31, 2018

China aims to launch a rocket larger than NASA's SLS in 2028

Li Guoping, director of the Department of System Engineering at the China National Space Administration (CNSA), said at the World Conference on Science Literacy 2018 on Tuesday in Beijing that the Long March 9 would be capable of lifting 140,000 kilograms,

or 140 metric tonnes, to low Earth orbit (LEO), according to the preliminary design.

Source: [GB Times](#), September 19, 2018

SpaceX President Gwynne Shotwell: ‘We would launch a weapon to defend the U.S.’

During an appearance on Monday at the Air Force Association’s annual symposium, Shotwell was thrown a question she said she had never heard before: “Would SpaceX launch military weapons?” “I’ve never been asked that question,” Shotwell said somewhat surprised. Her response: “If it’s for the defense of this country, yes, I think we would.”

Source: [Space News](#), September 17, 2018

They Made It! Japan's Two Hopping Rovers Successfully Land on Asteroid Ryugu

Two tiny hopping robots have successfully landed on an asteroid called Ryugu — and they've even sent back some wild postcards from their new home. The tiny rovers are part of the Japan Aerospace Exploration Agency's Hayabusa2 asteroid sample-return mission. Engineers with the agency deployed the robots early Friday (Sept. 21), but JAXA waited until today (Sept. 22) to confirm the operation was successful and both rovers made the landing safely.

Source: [Space.com](#), September 22, 2018

Musk’s SpaceX lands new Japanese client for lunar rover mission

Elon Musk’s Space Exploration Technologies Corp. signed its second Japanese customer in as many weeks—but the payload this time will be lunar rovers rather than a group of space tourists.

Tokyo-based lunar-exploration startup Ispace has signed up for launches on SpaceX’s Falcon 9 rocket in 2020 and 2021. The first will carry a lunar lander into orbit around the moon, and the second aims to put one on the moon’s surface so it can deploy a pair of rovers, Ispace said Wednesday.

Source: [LiveMint](#), September 26, 2018

Isro plans its first ground base at North Pole

The Indian Space Research Organisation (ISRO) is drawing up plans to set up its inaugural overseas ground station at the North Pole. The objective of the plan is to increase the Indian Remote Sensing (IRS) operations that are critical not only for civilian needs like disaster management but also for the armed forces. China has already had a functional ground station at the North pole.

Source: [MSN](#), September 4, 2018

Internet speed test: 100 Gbps by 2019! ISRO says these 4 satellites will make it possible

With an aim to provide equal digital speed in rural and urban areas and bolster the overall internet speed in India, the Indian Space Research Organisation (ISRO) has been banking on four high-throughput satellites-GSAT-19, GSAT-29, GSAT-11 and GSAT-20, to achieve the goal. While Gsat-19 was launched in June, 2017, GSAT-29 will be launched in November, and GSAT-11 and GSAT-20 will be launched in December and by next year.

Source: [Financial Express](#), September 24, 2018

ISRO's GSAT-29 launch in October

The launch of the GSAT-29 satellite will propel Prime Minister Narendra Modi's Digital India programme. One of the targets of the mission is to ensure that Village Resource Centres (VRC) in rural areas can successfully bridge the digital divide. According to the space agency GSAT-29 is configured around ISRO's Enhanced I-3K Bus and will be the payload for second developmental flight of GSLV MK3. It carries Ka x Ku multi-beam and optical communication payloads for the first time.

Source: [Economic Times](#), September 20, 2018

Cabinet approves new telecom policy to attract \$100 bn investment, create 4 mn jobs

The Union Cabinet on Wednesday approved the new telecom policy – the National Digital Communications Policy 2018 -- which aims to create four million jobs, draw a whopping \$100 billion of investments into the telecom industry by 2022, boost the sector's contribution to 8% of GDP from 6% in 2017 besides backing the principles of net neutrality.

Source: [Economic Times](#), September 26, 2018

UAE's first rendezvous with space set for April 5

Hazza Al Mansouri and Sultan Al Niyadi were announced as the country's first two astronauts earlier this month and both are currently in Russia for training. Only one of them will be chosen to fly to the ISS onboard the Russian spacecraft, Soyuz MS-12, for the 12-day trip. He will be joined by a Russian commander and an American flight engineer.

Source: [Khaleej Times](#), September 30, 2018

'Martian dirt' may unveil how to grow space food

Scientists have created experimental Martian dirt – a simulant that closely resembles the soil on Mars and could help find ways to grow food on the red planet for future human colonies. Researchers from University of Central Florida (UCF) in the US developed a scientifically based, standardised method for creating Martian and asteroid soil known as simulants.

Source: [Indian Express](#), September 30, 2018

A Key Ingredient for Life Fell To Earth from Outer Space

Whether the necessary ingredients for life come baked into a planet when it's born or they're added later by meteorites and comets is a source of much debate. The latest study from researchers at the University of Hawaii at Manoa provides compelling new evidence that phosphorous compounds at least were generated in space and came to Earth in its first billion years on the backs of falling space rocks.

Source: [Forbes](#), September 30, 2018

Politics and Space Meet at UN with 'Space2030: Space as a Driver for Peace'

At "Space2030," an inflatable orb called the "Black Marble Earth," which shows what the planet would look like from space at night, served as a stunning backdrop for high-level conversations about the future of human activity in space.

Source: [Space.com](#), September 27, 2018

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Leonard David, "[Would Trump's 'Space Force' Patrol the Moon?](#)," *Scientific American*, September 30, 2018

Joel Wooten, "[A Decade Of Commercial Space Travel – What's Next?](#)," *The Conversation*, September 30, 2018

Marina Koren, "[Mike Pence's Outer-Space Gospel](#)," *The Atlantic*, August 23, 2018

Michael Listner, "[The art of lawfare and the real war in outer space](#)," *The Space Review*, September 17, 2018

Pratik Jakhar, "[How China's GPS 'rival' Beidou is plotting to go global](#)," *BBC*, September 20, 2018

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Jeff Foust, "[British launch plans finally lift off](#)," *The Space Review*, July 23, 2018

Frank A. Rose and Jonathan D.T. Ward, "[Pompeo and Mattis should add space cooperation to the U.S.-India strategic partnership](#)," *Space News*, September 20, 2018

Chethan Kumar, "[Chandrayaan-2: Several challenges to meet Jan 2019 deadline](#)," *Times of India*, September 25, 2018

Tim Fernholz, "[Silicon Valley is investing \\$19 million in space radar](#)," *Quartz*, September 29, 2018

Ajey Lele, "[India seeks its own 'Gagarin Moment'](#)," *The Space Review*, August 20, 2018

Sanjay Kumar, "[India's surprise plan to send people to space by 2022](#)," *Nature*, September 5, 2018

Helene Fouquet, Ania Nussbaum and Marie Mawad, "[Europe's Space Champions Need More Orders at Home to Beat Musk](#)," *Bloomberg*, September 10, 2018

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Alexandra Witze, "[The quest to conquer Earth's space junk problem](#)," *Nature*, September 5, 2018

Kenneth Chang, "[Meet SpaceX's First Moon Voyage Customer, Yusaku Maezawa](#)," *New York Times*, September 17, 2018

Mark Buchanan, "[Space Junk Now Presents a Clear and Present Danger](#)," *Bloomberg*, September 19, 2018

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REPORTS / STATEMENTS / MULTIMEDIA

[Joint Statement on the Fifth Meeting of the U.S.-Japan Comprehensive Dialogue on Space](#), US Department of State, July 23, 2018

Annual Report to Congress on “[Military and Security Developments Involving the People’s Republic of China 2018](#),” Office of Secretary of Defence, Released in August 2018

Carol Sunderland, “[Research into the value of satellite-derived Earth Observation capabilities to UK Government](#),” UK Government, July 2018

Mike Wall, “[Changing the Launch Equation: Q&A with Rocket Lab CEO Peter Beck](#),” Space.com, September 17, 2018

Rekha Dixit, “[Interview with Rakesh Sharma: Establish an inclusive society in space](#),” The Week, September 30, 2018

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Albert Harris, “Preparing for Multidomain Warfare: Lessons from Space/Cyber Operations,” *Air & Space Power Journal*, Vol. 32, Issue 3, August 2018, pp. 45-61

Bruce Cahan et. al., “Space Commodities Futures Trading Exchange: Adapting Terrestrial Market Mechanisms to Grow a Sustainable Space Economy,” *NewSpace*, Vol. 6, Issue 3, September 2018, pp. 211-226

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Stewart Patrick and Kyle L. Evanoff, “[The Right Way to Achieve Security in Space](#),” *Foreign Affairs*, September 2018

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John Logsdon and Bill Nye, *NASA and the Incredible Story of Human Spaceflight* (Penguin Classics: London, September 2018)

Tom James ed., *Deep Space Commodities: Exploration, Production and Trading* (Palgrave Macmillan: United Kingdom, August 2018)

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