



Space Alert

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Bangalore Space Expo 2016: Highlights and Recommendations

Narayan Prasad

The fifth edition of the biennial Bangalore Space Expo was held in September 2016 at Bangalore. It was organised by the Indian Space Research Organisation (ISRO), its commercial arm Antrix Corporation Limited and the Confederation of Indian Industry (CII) with France being the partner country. It featured delegates from 12 countries and attracted over 3,200 business visitors.

On the opening day, ISRO Chairman informed that that the country has a constellation of 34 satellites fulfilling earth observation, communication, navigation, and other space science requirements of the country. He remarked that, *“this is significantly short, and we need to at least double the number of satellites to give reasonable service to the country. Launch capability must be enhanced, and satellite building must be made faster to get optimal use of space services. We have set in process, we still have a long way to go because today we are not able to increase our launch frequency because the supply chain that exists today is still inadequate to meet our demand.”*

Opportunities for the Private Sector

This increase in demand is primarily driven by the Centre and State governments, which have realised the need for space technology in planning and executing various projects. Interestingly, only 20 central government departments were witnessed to be using space technology in the first 35 years of its development in the country. At present, over 60 central government departments and all state governments are now working with

ISRO to utilise the country’s space capabilities.

The ISRO leadership is also keen on handholding the private sector to meet this rising demand. The private industry is gradually being upgraded to build satellites and launch them without particular input from ISRO. It had recently floated a Request of Interest (RoI) for satellite integration at ISRO Satellite Centre (ISAC) by the private sector. ISRO Chairman mentioned that there has been an overwhelming response for the recent RoI from the private sector with more than 40 companies submitting their bids to participate in building satellites.

International Participation

Apart from France being the partner country for the Space Expo, the event also witnessed major participation with delegations arriving from Switzerland and Australia. Heads of major industries, space start-ups, small and medium enterprises, academia formed part of these delegations. A Swiss Pavilion was hosted at the Bangalore Space Expo with a special Innovation Pitch event held during the conference to present Swiss product and service innovations. Similarly, Space Industry Association of Australia (SIAA) trade delegation arranged and supported by the Australian Consulate in Chennai participated in the conference to showcase the interest in collaboration for space exploration.

Start-ups Session

The conference provided critical engagement opportunities for space start-ups from India and abroad. A lightning talk by Bengaluru-based start-up Astrome Technologies founded by alumni of the Indian Institute of Science showcased their plans of a space network of

150 small, internet-friendly high-throughput satellites covering the globe by 2020. A follow-up panel saw participation from other Indian start-ups including Team Indus, Dhruva Space and international start-ups including Planet Labs (USA), Innovative Solutions in Space (The Netherlands) and HEIG-VD (Switzerland).

Follow Up to the Space Expo 2016

The CII has formed a task force of leading companies to chart out a roadmap for developing a space ecosystem in the country. A tentative committee of 15 public and private sector companies met during the Space Expo to discuss a broad agenda. The committee includes representatives of established and prospective suppliers of India's space viz., Godrej Aerospace, Tata Advanced Systems Ltd, Tata Advanced Materials Ltd, Mahindra Aerospace, L&T, Reliance Space, Astra Microwave and a few Bengaluru ventures. It is pegged that an expanded committee of decision makers will meet regularly under the lead of Antrix Corporation Ltd. to come up with an action plan to create a solid, independent space industry base likewise in the U.S. and Europe.

Recommendations for Space Expo 2018

- Introduce the culture of closing commercial deals and MoUs for cooperation (both locally and globally) during the Space Expo.
- Release an annual report on the 'State of the Indian Space Industry', which can draw a lot of inspiration from similar practices from the international space industry to provide an overview of the current capabilities of ISRO and the industry. This can also be an opportunity to showcase the

significance of Indian companies cooperating with foreign companies.

- The CII should promote Indian SMEs in the space industry by instituting awards in different categories like:
 - Best SME
 - Best Space Spin-off
 - Best Space Start-up
- The CII should also promote the participation of Indian industry along with ISRO in the largest space conference of the world – the International Astronautical Congress. The Space Expo awards can be utilised as benchmarks for choosing the industries that will be allowed to travel with ISRO to this Congress for showcasing their products and services.
- Include the debate on regulatory issues in the Bangalore Space Expo and invite legal experts in the country to discuss relevant issues with industry and agency officials.
- Help start a directory of space companies, capabilities, etc. which can be easily accessible to the international market in order to promote the ease of doing business.

Narayan Prasad is a co-founder of Dhruva Space, a Bengaluru based NewSpace company established in 2012 with a vision to lead the turnkey satellite development industry in India. He can be reached @cosmosguru

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India Operationalises the GSLV

Vidya Sagar Reddy

The recent successful launch of Geosynchronous Launch Vehicle (GSLV) is a milestone in India's space programme. This is the first operational flight of the GSLV with an indigenous cryogenic engine upper stage helping India reduce its dependence on foreign launch vehicles. The history behind India finally mastering the cryogenic technology is evidence of the determination of Indian Space Research Organisation's (ISRO) efforts at indigenisation.

The cryogenic science is the art of liquefying gases like Hydrogen and Oxygen. Oxygen liquefies at -183°C and Hydrogen at -252.9°C . Hydrogen has low molecular weight and burns with high intensity while oxygen is one of the easily available oxidising agents. A cryogenic rocket engine using these liquefied gases provides more thrust for every kilogram of fuel consumed when compared to other propellants, raising the payload capacity of the launch vehicle. The liquefaction process also increases the density of these gases allowing them to be stored in smaller containers on-board rockets.

Communications satellites that need to be placed in the geostationary orbit and other heavier satellites including planetary probes are launched using these engines. The Saturn V launch vehicle that placed humans on the moon and the space shuttle in addition to Delta IV, Ariane 5, Long March 5 uses cryogenic engines.

Designing a cryogenic engine that can withstand the structural pressure and heat emanating from the combustion of these fuels involves sophisticated engineering and material science. Therefore, the cryogenic

engine technology is a closely guarded secret of advanced spacefaring countries. With the Polar Satellite Launch Vehicle (PSLV) satisfying the launch requirements of India's remote sensing satellites, ISRO began to focus on cryogenic engine development for launching the communications satellites indigenously under the GSLV programme. India was thus far reliant on Ariane launch vehicle to meet this requirement.

In 1990s, ISRO signed an agreement with the Russian space directorate Glavkosmos to transfer Russian cryogenic engine technology to India. Citing India's missile development programme, the United States imposed Missile Technology Control Regime sanctions on both ISRO and Glavkosmos in 1992. India argued against the sanctions saying that the technology is intended for civilian space programme and is not suitable for meeting ballistic missile requirements.

However, Russia decided to suspend the initial contract and forged a new one in 1994 where India would simply buy the cryogenic engines without any transfer of technology. This episode is by far the lowest point in India-US space relationship as it pushed back the development of GSLV forcing India to continue to rely on foreign launchers.

India finally bought Russian engines but decided to kick start the indigenous development of this technology. The GSLV is designated Mark I when these engines were used and Mark II when the indigenous engines are utilised. The Mark I launches offered India more failures than successes. India started flight testing the indigenous cryogenic upper stage in 2010. This first development flight was a failure but the subsequent tests in 2014 and 2015 were successful leading to the first successful operational flight of Mark II version in September 2016.

India is now gearing to launch at least two GSLVs per year and has already lined up Satellite for SAARC as well as Chandrayaan 2 as payloads. More successful flights will help India establish a track record in this payload capacity segment required for entering the international market. Along with the PSLV's capacity to place 1,750 kg into a 600 km orbit, India could offer GSLV capable of launching 5,000 kg to low earth orbit. This capacity is especially critical as the Cubesat standard continues to disrupt the traditional business models of satellite manufacturing and launch services.

University students now have access to commercial-off-the-shelf satellite components for building demonstrator missions while many entrepreneurs now look at small satellites for their business needs in weather forecasting, imaging, navigation etc. Both space and non-space commercial entities like OneWeb, Google and Facebook are vying to launch hundreds of small satellites into low earth orbit for providing internet across the globe. Outer space is providing the common platform for the world opening to knowledge economy.

India's PSLV has already launched small satellites from a few countries even as ISRO is experimenting with different technologies for expanding the scope of the launch vehicle in this market. ISRO had successfully restarted the fourth stage (liquid fuelled) of this launch vehicle enabling it target multiple orbits. The GSLV will also need to prove this capability to take advantage of the emerging small satellite market in addition to launching heavier interplanetary probes.

The operationalisation of this launch vehicle will allow ISRO to concentrate its resources on building the next generation launch

vehicles meant for carrying heavier payloads and possibly human space missions.

The GSLV's launch capacity to low and medium earth orbits enhances India's capability to build and launch advanced Intelligence, Surveillance and Reconnaissance satellites, especially electronic intelligence and missile warning sensors. It is imperative to possess situational awareness across India's border, air and maritime spaces in addition to providing updated information to assets deployed outside the territorial limits for safeguarding national interests and security.

The plans to increase the frequency of PSLV (especially with commercialisation efforts) and GSLV flights puts into perspective the construction of second vehicle assembly building and the desire for a third launch pad. The second vehicle assembly building will allow ISRO simultaneously assemble three launch vehicles in total while the third launch pad will help distribute the workload between the three launch pads. The third launch pad is also designed for launching heavier vehicles than GSLV Mark II.

The operationalisation of the GSLV signals ISRO's confidence in the indigenously developed cryogenic technology after a series of failures and uneventful situations. This launch opens a multitude of opportunities to India in terms of economy, security and innovation. This achievement saves India's precious foreign reserves as well as showcases the country's technological might to the world.

Vidya Sagar Reddy is a research assistant in the Nuclear & Space Policy Initiative of the Observer Research Foundation, New Delhi. He can be reached @avs_reddy

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A Common Space Forum for Asia: Should India take the lead?

Pranaav Gupta

Vikram Sarabhai, the legendary Indian physicist who is credited as the father of the Indian space program, has said, “there are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose. We do not have the fantasy of competing with the economically advanced nations in the exploration of the moon or the planets or manned space-flight. But we are convinced that if we are to play a meaningful role nationally, and in the comity of nations, we must be second to none in the application of advanced technologies to the real problems of man and society.”

The Indian Space Research Organisation has come a long way since the days of Dr. Sarabhai now not only competing with advanced nations such as Japan, the United States and other European countries but is also launching their satellites. As India embarks on this new journey in space, it cannot be a more opportune moment to advocate for the possibility of a new Asia-Pacific Space Forum.

Given India’s proven space-faring capabilities and the prestige with which its space achievements are looked at, the potential for such a forum to solve “real problems of man and society” is truly vast. There is a need to add a semblance of normalcy to outer-space. India has the moral position and the technical know-how to go about doing this.

The most important question that emerges now is whether India has the political will to advocate for the creation of such a forum.

India must show the ability to harness the power of the dawn of the Asian century. The fact that such space cooperation not only benefits India but also Asia is undeniable.

The status quo of space cooperation in Asia presents a bifurcated structure, shaped by the two distinctive cooperation initiatives - Asia-Pacific Space Cooperation Organization (APSCO) and Asia-Pacific Regional Space Agency Forum (APRSAF) led by China and Japan respectively. According to Professor Kazuto Suzuki, these two organizations were created due to rivalry between Japan and China but they have no substantive gains to their credit.

Having said that, the important question that arises now is that, given the fact that the ISRO is already doing a commendable job with regard to space cooperation – having agreements with more than 57 countries – will a new India led space forum really be in India’s interest?

I would argue that India’s successful efforts in distributing the benefits of space technology for socio-economic development of the country, the operational directive set by Dr. Vikram Sarabhai, is a strong evidence for India creating an alternative formal space forum that will institutionalize such cooperation. This forum should focus on space research and development to drive innovation. International cooperation is not only important but has become a necessity.

The recent agreement between China’s President Xi Jinping and India’s Prime Minister Narendra Modi to pledging to cooperate in space exploration is a good sign. Whether this initiative can overcome decades of mistrust and help lead the region out of its current hostility remains to be seen. In light of

these developments, it is opportune for India to ensure that common interests are aggregated and expressed via an India-led Asia Pacific Regional Space Forum.

Further, in 2012, the then DRDO chief V.K. Saraswat emphasized a defensive strategy for India in the space domain. Sticking to the principle of “non weaponisation,” Dr. Saraswat projected the view that space security entails the creation of a gamut of capabilities including the protection of satellites, communications and navigation systems and denying the enemy the use of their own space systems. It is the creation and the protection of these capabilities that require an India-led space forum.

At the last SAARC Summit in Kathmandu, India offered to launch a communications satellite for the benefit of all South Asian nations called Satellite for SAARC. This idea for a common satellite, however, was turned down by Pakistan arguing that the satellite should be SAARC-led as against India’s gifting. Nevertheless, India decided to launch the satellite this year that will mutually benefit the remaining SAARC countries in tele-education, tele-medicine and for responding to natural disasters.

It can be argued that the Asia Pacific forum that is being mooted must also avail India more opportunities to focus on its neighborhood countries. In addition to the SAARC satellite, India can propose more collaborative projects like developing Data Reception, Tracking and Telemetry stations in the neighborhood using the proposed forum.

While there is no doubt that the ISRO is playing a pivotal role in contributing to India’s

enhanced foreign policy stature, a diplomatic forum will provide an opportunity for developing countries to collaborate with India via the process of a formal institutional architecture. India that adheres to the peaceful uses of outer space and international cooperation has an ideal opportunity to take the lead in such an organisation.

Pranaav Gupta is a fourth year law student at the West Bengal National University of Juridical Sciences, Kolkata. He has keen interest in Space Law and is presently conducting research on the feasibility of creating an alternative common space forum for Asia. He can be reached at pranaav.gupta@gmail.com

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FROM THE MEDIA

In a first, PSLV launches eight satellites into two different orbits

The rocket was re-ignited twice during its flight to place the set of satellites in different orbits. Due to the re-ignition, the Monday's launch is by far the longest PSLV launch by ISRO.

Source: [The Hindu](#), September 26, 2016

ISRO sets the ball rolling for Mars Mission-2

Nearly three years after it launched a world record making MOM (Mars Orbiter Mission) the Indian Space Research Organisation has invited Indian planetary scientists from the academia and research bodies to suggest which aspects of Mars should now be studied, along with the instruments they can provide for MOM-2.

Source: [The Hindu](#), August 10, 2016

Suit, Craft Ready, But India's Space Odyssey Gets A Go Slow Signal

India will not be putting a man in space anytime soon. Jitendra Singh, the minister in charge of India's space programmes, has recently told (Indian) Parliament "as of now, manned space programme is not an approved programme."

Source: [NDTV](#), August 4, 2016

Successful Flight Testing of ISRO's Scramjet Engine Technology Demonstrator

The first experimental mission of ISRO's Scramjet Engine towards the realisation of an Air Breathing Propulsion System was

successfully conducted from Satish Dhawan Space Centre SHAR, Sriharikota.

Source: [ISRO](#), August 28, 2016

ISRO planning record 68 satellites' launch next year

Indian Space Research Organisation (ISRO) is planning for the launch of a record 68 satellites in one mission by early next year. The satellites will be nano in nature from foreign countries

Source: [Indian Express](#), August 30, 2016

Small is big for the Indian space industry

"They will have to take several steps and grow in phases, everything won't happen overnight. There is a lot of potential in the small satellites segment and the subsystems segment where they will have to immediately focus on."

Source: [Times of India](#), August 30, 2016

ISRO plans to launch first privately built satellite by March

The space agency plans to hand-hold vendors to jointly build, test and certify two navigation satellites that it would launch to join the fleet of seven Navic satellites already in space.

Source: [Business Standard](#), September 3, 2016

'India's space capacity is severely constrained'

India's space capacity of 34 working satellites of three categories is barely half of what it should be and is severely constrained to meet all demands in the country, the chief of ISRO admitted.

Source: [The Hindu](#), September 1, 2016

Now, ISRO eyes missions to Venus

The ISRO is mulling over missions to Venus or an asteroid and is under discussions for these, apart from a second mission to Mars, ISRO Chairman A.S. Kiran Kumar said.

Source: [The Hindu](#), September 9, 2016

ISRO-PRL's observatory at Mt Abu to track space junk

The new observatory, widely categorized as the Electro-Optical Deep Space Surveillance system, will track space debris - mainly consisting of inactive satellites, electronic parts of instruments, leftovers from rocket launch and other such junk.

Source: [Times of India](#), September 20, 2016

Mega launchers for ISRO soon

When fitted suitably into a launch vehicle, the new engine will see India putting satellites of the class of 6,000 to 10,000 kilos — or with some variations, lift even 15,000-kg payloads — to geostationary transfer orbits at 36,000 km.

Source: [The Hindu](#), September 28, 2016

ESA gives final approval for Ariane 6; Airbus Safran Launchers now in control

Meeting at ESA's headquarters here, the agency's ruling council approved the release of the second and final tranche of funds for Ariane 6, with the transfer of funds to Ariane 6 prime contractor Airbus Safran Launchers to occur in late October.

Source: [Space News](#), September 13, 2016

ESA Plans to Work Together With Russia on Moon Exploration

The European Space Agency plans to cooperate with Russia's Roscosmos on lunar research, Rene Pischel, the head of the ESA's permanent mission in Russia said. Roscosmos deputy chief Sergei Savelyev confirmed earlier that the two space agencies were mulling joint flights to the moon as continuation of their work on the ExoMars program.

Source: [Sputnik News](#), September 21, 2016

Russia, China move closer to joint moon, Mars missions

"We're developing an understanding for the rocket and space industry for possible interaction in such profound and technologically complex projects as the future exploration of the moon, Mars and piloted cosmonautics."

Source: [The Washington Times](#), July 14, 2016

China launches second experimental space lab module

China launched its second experimental space laboratory on Thursday, part of a broader plan to have a permanent manned space station in service around 2022.

Source: [Reuters](#), September 16, 2016

China to expand international astronauts exchange

China will expand international exchange in the training of astronauts in a bid to push it closer to becoming a space power, an official said Wednesday.

Source: [Xinhua](#), July 27, 2016

China's satnav industry grows 29 pct in 2015

The output value of China's satellite navigation and location-based service industry grew 29.2 percent year on year in 2015, with the country's self-developed BeiDou Navigation Satellite System making a big contribution, according to a white paper.

Source: [Xinhua](#), July 20, 2016

Vector Space Systems plans 2018 first flight of small launch vehicle

A startup developing a small launch vehicle says it's on schedule for a first launch in 2018 after completing the acquisition of another small launch company.

Source: [SpaceNews](#), July 22, 2016

GAO warns of Orion cost and schedule concerns

NASA has a less than 50 percent chance of achieving its goal of launching the first crewed Orion mission in August 2021, and pressing towards that goal could result in additional budget and schedule problems, a U.S. Government Accountability Office report warned.

Source: [SpaceNews](#), July 28, 2016

'Neighborhood watch' satellites headed to space

The US Air Force's Geosynchronous Space Situational Awareness Program, or GSSAP, plans to fly four satellites above and below the "GEO belt," circling it and weaving from side to side to capture up-close views of everything flying there.

Source: [USA Today](#), August 19, 2016

Air Force sent GSSAP satellite to check on stalled MUOS-5

The U.S. Air Force sent one of its high-orbiting space surveillance satellites to check on a Navy communications satellite that ran into propulsion problems about halfway to geosynchronous orbit.

Source: [SpaceNews](#), August 18, 2016

Blue Origin Announces Big 'New Glenn' Rocket for Satellite & Crew Launches

"Our vision is millions of people living and working in space, and New Glenn is a very important step," Bezos said. "Up next on our drawing board: New Armstrong," Bezos teased, referencing Neil Armstrong, the first human to walk on the moon.

Source: [Space.com](#), September 12, 2016

SpaceX rocket explodes at Cape Canaveral ahead of launch

The rocket's payload, an Israeli-built communications satellite for Facebook, was also destroyed. Facebook, in partnership with Eutelsat Communications, had been due to use the Amos-6 satellite to deliver broadband internet coverage for swathes of sub-Saharan Africa as part of its Internet.org initiative.

Source: [BBC](#), September 1, 2016

FAA Poised to Take On Role as Traffic Cop for Space

With roughly 1,400 commercial satellites currently flying and several thousand more expected to be launched into popular low-altitude orbits over the next 10 years, Pentagon brass are ready to hand over the painstaking task to civilian authorities.

Source: [The Wall Street Journal](#), September 18, 2016

NASA's OSIRIS-REx Speeds Toward Asteroid Rendezvous

Scientists suspect that asteroids may have been a source of the water and organic molecules for the early Earth and other planetary bodies.

Source: [NASA](#), September 9, 2016

Sisi to relaunch Egypt's space agency: NARSS official

President Abdel Fattah al-Sisi is seeking to relaunch the Egyptian space agency project that stumbled in the 1960s, according to Alaa al-Nahry, the deputy head of the National Authority for Remote Sensing and Space Sciences.

Source: [Egypt Independent](#), August 1, 2016

National Space Policy adopted by UAE Cabinet

Sheikh Mohammed bin Rashid, Vice President and Ruler of Dubai, said the National Space Policy would advance the UAE's involvement in space exploration and establish it as a major player before the country's 50th anniversary in 2021.

Source: [The National](#), September 4, 2016

UAE Space Agency announces details of national space policy

The policy aims to build a strong and sustainable space sector in the UAE that supports and protects national interests and related vital industries. It also ensures the sector's contribution to economic growth and diversification, honing the skills of Emiratis and developing their scientific and high-tech capabilities.

Source: [Emirates News Agency](#), September 7, 2016

Iran, Roscosmos Discuss Price of Remote-Sensing Satellite Construction, Launch

Tehran and Russia's Roscosmos space corporation agreed on the general design, development and launching of a remote-sensing satellite for the needs of the Middle Eastern country and are negotiating the financial aspect of the deal.

Source: [Sputnik News](#), August 6, 2016

Russian space corporation expects considerable cuts in budget funding

"There are different figures by the programs. However, rather serious cuts are expected in general. We are currently discussing these issues. The exact figures will be known after we approve them."

Source: [TASS](#), September 6, 2016

Thales, SES to Offer Broadband for Air Passengers

Europe's largest satellite-services provider and the region's leading aircraft-electronics maker are teaming up to offer enhanced broadband-via-satellite connections to airline passengers.

Source: [The Wall Street Journal](#), September 11, 2016

Satellite Startup LeoSat Secures Customer for High-Speed Trading

LeoSat is betting about \$3.5 billion that minute differences in the speed it takes light to transit through space compared to the time it takes the signal to travel through fiber-optic cables will help create a satellite services market that hasn't existed before.

Source: [The Wall Street Journal](#), September 6, 2016

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OPINIONS AND ANALYSES

Eric R. Hedman, "[The human spaceflight equation](#)," *The Space Review*, July 18, 2016

Jeff Foust, "[For smallsats, launch options big and small](#)," *The Space Review*, August 15, 2016

Nickolas J. Boetsch, "[Middle Eastern Lunar Missions: the Role of the Moon in the Middle East's Spacefaring Future](#)," *SpaceWatchME*, August 21, 2016

Théo Pirard, "[An interview with Jean-Yves Le Gall, president of CNES](#)," *The Space Review*, September 12, 2016

Josh Chin, "[China's Latest Leap Forward Isn't Just Great—It's Quantum](#)," *The Wall Street Journal*, August 20, 2016

Michael Raska, "[Where quantum satellites fit in PLA strategy](#)," *The Lowy Interpreter*, September 8, 2016

David Axe, "[Three Words: Chinese. Space. Station.](#)," *The Daily Beast*, September 19, 2016

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Mike Gruss, "[Good \(space\) fences make for good \(orbital\) neighbours](#)," *SpaceNews*, September 19, 2016

Michael Scaturro, "[New space race signals price crash for satellite data](#)," *Live Mint*, September 23, 2016

Brian Weeden, "[Time for the U.S. military to let go of the civil space situational awareness mission](#)," *SpaceNews*, September 20, 2016

Nola Taylor Redd, "[Touching an Asteroid: The Science Behind NASA's OSIRIS-REx Mission](#)," *Space.com*, September 7, 2016

Carl Engelking, "[What's Bad for SpaceX Is Good for Russia](#)," *Discover*, September 1, 2016

Pavel Luzin, "[Russia's Position in Space](#)," *Foreign Affairs*, September 21, 2016

Chris Buckley and Adam Wu, "[China Hunts for Scientific Glory, and Aliens, With New Telescope](#)," *New York Times*, September 25, 2016

Elizabeth Howell, "[Tanegashima: Japan's Largest Space Center](#)," *Space.com*, September 30, 2016

Donna Dawson, "[The emerging commercial space industry](#)," *Composites World*, July 11, 2016

Yaacov Benmeleh, "[Israel's Space Plan Exploded With SpaceX Rocket. Now What?](#)," *Bloomberg*, September 5, 2016

Mark Williamson, "[Commercial space launches at Cape Canaveral](#)," *The Institution of Engineering and Technology*, July 12, 2016

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NEW PUBLICATIONS

REPORTS/STATEMENTS/ MULTIMEDIA

ISRO is [soliciting proposals](#) from interested scientists within India for experiments onboard an orbiter mission around Mars (MOM-2) to address relevant scientific problems and topics.

NASA released [report](#) on 'Economic Development of Low Earth Orbit'

US Space Command [White Paper](#) on Space Mission Force: Developing Space Warfighters for Tomorrow

ISRO has developed weather data explorer application named Real Time Analysis of Products and Information Dissemination ([RAPID](#)) for visualisation and analysis of meteorological data from Kalpana-1, INSAT-3A and INSAT-3D

China's State Council Information Office published a [white paper](#) titled "China's BeiDou Navigation Satellite System"

Elon Musk's [Vision](#) for Affordable Space Travel to Mars

JOURNAL ARTICLES

Bastida Virgili et. al., "Risk to space sustainability from large constellations of satellites," *Acta Astronautica*, vol. 126, September-October 2016, pp. 154-162

Ward Hanson, "Satellite Internet in the Mobile Age," *New Space*, vol. 4, no. 3, September 2016, pp. 138-152

Tom Boone and David Miller, "Capability and Cost-Effectiveness of Launch Vehicles," *New Space*, vol. 4, no. 3, September 2016, pp. 168-189

Amelia Rai et. al., "Expanded benefits for humanity from the International Space Station," *Acta Astronautica*, vol. 126, September-October 2016, pp. 463-474

BOOKS/MONOGRAPHS/OCCASIONAL PAPERS

Jon Willis, *All These Worlds Are Yours: The Scientific Search for Alien Life* (Yale University Press: US, August 2016)

Bruce MacDonald, Admiral Dennis Blair, Dean Cheng, Karl Mueller and Victoria Samson, "[Crisis Stability in Space: China and Other Challenges](#)," *The Foreign Policy Institute of The Johns Hopkins University*, September 2016

David Livingstone and Patricia Lewis, "[Space, the Final Frontier for Cybersecurity?](#)" *Chatham House*, September 2016

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