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TIP

TECHNOLOGY INNOVATION PRODUCTIZATION

75 Students' Satellites Mission 2022

Satellites for Everyone and Space for Everyone

INDIAN
TECHNOLOGY
CONGRESS

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TIP TECHNOLOGY INNOVATION PRODUCTIZATION
Volume 8 • Issue 1 • September 2021

Mission
Enable lively debate,
inspire and enrich the technology
community of India

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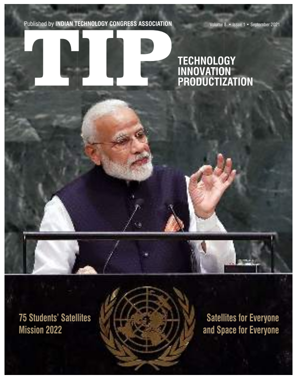
CONTENTS



The Commercial Space Era
is here and now...

On 20 July 2021, Jeff Bezos, founder of Amazon and presently the leader of the Global Billionaire's list, blasted off into suborbital space in a shuttle Blue Origin, operated by his business, heralding a new era of space exploration for private citizens. Likewise, Sir Richard Branson soared into space in his VSS Unity, a rocket operated by Virgin Galactic earlier that month. In the meantime, SpaceX, founded by Elon Musk with the goal of reducing space transportation costs, has partnered with the National Aeronautics and Space Administration (NASA) of the USA to carry astronauts to the International Space Station.

While Bezos has articulated his long-term vision of establishing space colonies using the lunar lander Blue Moon, there has been a quiet revolution in the space sector with new organizations and commercial entrepreneurs entering the space domain. Traditionally, the space realm has been occupied by institutional players, including government-operated national space agencies that collaborated with private sector companies to address new opportunities. For the first time in history, citizens have accessed space by a vehicle built and owned not by any governmental agency but by a private enterprise with its vision set on affordable space settlement. The implications are humungous for public policy, industry and society at large. In recent years, nations have made significant advances in space programmes; despite the COVID pandemic that delayed or hampered most of the mission.

Governments dominated space exploration in the early days of Old-Space because of the enormous investments required and the high risks involved. National pride was another key motivator and the intent to be the first in achieving the significant landmark. Entrepreneurs and businesses with fewer resources had little reason to pursue space exploration programmes because the probability of crossing myriad regulatory hurdles and generating decent returns on investment seemed a distant dream.

The democratization of space is a recent and enabling phenomenon, bringing in new participants and unveiling new business opportunities. Like the dot-com era in the early years of the twenty-first Century spawning numerous start-ups, New Space is today's ecosystem providing the fostering-base for countless business ideas. Successful entrepreneurs from other sectors have entered the Space arena, embracing risks and challenging the conservativism of the hitherto established Old-Space business model.

New Space is technologically advanced on a revolutionary paradigm of building affordable satellites in shorter time frames, leading to decreased costs due to the downsizing of satellite components and subsystems. As a result, the value and commercial advantages traditionally reserved exclusively for national space agencies are now accessible to commercial enterprises and academic institutions.

The slashing of costs for launch and space hardware has attracted new entrants into this market. Industries across multiple sectors have begun leveraging satellite technology and access to space to enhance operational efficiency and promote competence in their products and services. According to industry analyst

Editor-In-Chief

L V Muralikrishna Reddy, PhD
President
Indian Technology Congress Association

Morgan Stanley, the global space industry is expected to generate USD 1.1 trillion or more in 2040, up from the USD 350 billion presently.

The Government of India created a new entity, the Indian National Space Promotion and Authorization Center (IN-SPACe), to increase private participation in India's space programmes to significantly boost the current Indian share of 2% of the world space economy to higher levels.

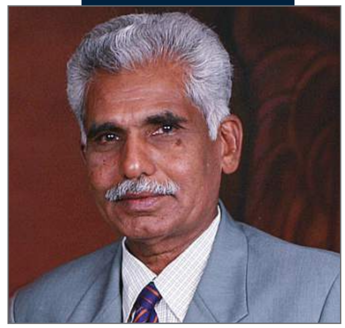
ITCA's Students' satellite mission is also gaining pace despite the pandemic headwinds, and it has recently launched Three satellites under the name UnitySAT and has signed up few new assignments. The ITCA satellite mission, which have the support of the WCRC, UNISEC, and other international partners, are adding substantial value & knowledge to the framework.

Addressing the 76th session of the United Nations General Assembly, Prime Minister Shri Narendra Modi articulated India's unique and ambitious mission of launching 75 satellites into space, built by students from Indian educational institutions on the occasion of India's 75th Independence year. This is a significant boost for ITCA's 75 Students' Satellites Mission 2022 engagements.

Satellite for Everyone and Space for Everyone is the theme of this year's ITC-2021. Many national and international experts presented their collaborative contributions of the space sector to wide range of participation.

Chairman National Advisory Committee ITC 2021

Satellites Evolution and Trends



Prof. R.M. Vasagam
Vice President
Indian Technology Congress Association

The space age was ushered in by launch of Sputnik by USSR on 4 October 1957 and the satellite systems have been harnessed by the leading space powers and agencies all over the world for international and domestic telecommunications, remote sensing of natural resources and meteorology, mapping and navigation satellites. Space Science Missions to study earth, moon, sun and explorations of planets like Mars, Jupiter, Saturn, Pluto, Neptune, Venus, Mercury and asteroids. Space telescopes have opened up the studies in UV, visible, near and far infrared, XRays, gamma rays and cosmic rays. Radio astronomy from ground based observatory complements the space based systems for solving the puzzles of origin of universe, solar system, origin of life, formation of black holes, dark matter and dark energy, gravitational waves and the connection between cosmic and subatomic events.

India joined space efforts when the field was at a nascent stage and has become a role model for many countries in the world by selective and imaginative use of space technology by creating end to end capabilities for space transportation, satellite systems, applications and connecting with the needs of accelerated national development leveraging the force multiplier effect thus maximising the return on investment. It also provides opportunities for talented persons to work on challenging tasks in interdisciplinary teams and come out with original and innovative solutions with participation by academic and research institutions and industry. Handholding the central and state government departmental users has been a distinct feature.

Having created a solid base though with frugal funding in comparison with advanced nations, India has taken the welcome step of opening up of space programme to Indian industries, entrepreneurs and start up companies supported by venture capital; a new dawn and beginning has been made recently. Access to ISRO knowhow, ISRO facilities and commercialising space services are key elements of the policy getting implemented..

Thus ISRO will be free to focus on new technologies for human space flight, recovery and reuse of launch vehicle elements and serviceable satellite systems and develop new technologies for harnessing manufacturing in space, space solar power and robotics for space based mining and in situ operations on moon, Mars and asteroids .

While these are showing the directions we are taking, we are confronted with disruptive technologies coming up in many countries. The Mini, Micro and Nano satellites are gaining in prominence by offering better services compared to satellites of few hundred to thousand kg class satellites especially for earth observation and constellations of small communication satellites in near earth orbits. The field is attracting new generation entrepreneurs who got into space ventures like Elon Musk, Bezzos and a host of others from South Korea, Japan Canada and Europe. India has Sunil Mittal investing in One Web. China and Russia are having their own entrepreneurs getting into this promising market.

Indian initiatives had begun with 40 kg Anna university student built Anusat Jugnu from IIT kanpur, Pratham from IIT Bombay, SRM and Studsat were sent orbit. With active mentoring Nurul Islam satellite, Pisat from PES were launched with funding support by institutions. It is only a small beginning when one considers more than 2500 Student built satellites built and launched world over already for a variety of missions.

Recently with the active involvement of student teams three Unity sat 330 gram satellites with inter satellite links and IoT mission were designed, tested and launched for Jeppiar Institute of Technology, Chennai, Sri Sakthi Engineering College, Coimbatore and GH Raisoni College of Engineering, Nagpur by student teams led by New Horizon Engineering college student Start up and mentored by ITCA and Veterans of ISRO. Improved models are already being built and may get early launch. Chandigarh University has started already for launch their student built Satellite. Thus these initiatives have created awareness among more institutions to come forward to join such missions as part of experiential learning. ITCA interactions with Israel institutions who supported the launch of their high school students built Satellite has made it possible to take similar strategies for small satellites getting built by government high school students in Karnataka in near future as part of 75 student built satellites to commemorate 75 years of India's Independence.

Thus human resource developed will make India a much sought after workplace for this cutting edge area of work if only we harness the potential. The technologies of complex systems learnt by doing Small Satellites open up opportunities at global level.

The theme of the ITC2021 is aptly chosen and let us hope the expectations will be more than fulfilled.

Suborbital Rocket Launches

NASA Challenges Students to Identify Experiments

The TechRise Student Challenge is open to students from grades 6-12 through 3 November 2021. NASA is looking for student teams to enter its TechRise Student Challenge, which tasks students in grades six through 12 with designing experiments to launch on a suborbital spaceflight. The initiative aims to familiarize students with the design and testing process that NASA researchers use.

A team of at least four students and an educator from a public, charter or private school can submit a proposal for an experiment to fly on one of two types of suborbital flight (in which the vehicle will reach space but not orbit the Earth) — a suborbital rocket or a high-altitude balloon.

The 57 winning teams will each receive $1,500 to build their experiment and a reserved spot to test it on either a rocket or balloon. The rockets include Blue Origin's New Shepard, Up Aerospace boosters and Raven Aerostar vehicles. Each team will also have access to expert help from Future Engineers, the organization administering the contest.

Proposals must be submitted via the Future Engineers website futureengineers.org by 3 November 2021. NASA will announce winners in Jan 2022, and experiments are planned to launch in early 2023. Students can also register for a virtual field trip hosted by NASA and Future Engineers on 24 September 2021, which will provide more information and project ideas.

Source: space.com

Removal of Space Debris

Astroscale's Satellite aces 1st Orbital Test- A Demonstration Mission

The ELSA-d spacecraft of Japan-based startup Astroscale has successfully captured a simulated piece of space junk, completing the first phase of a demonstration mission that could pave the way for a less cluttered future in orbit.

Launched on 22 March 2021, ELSA-d brought with it to orbit a 37-pound (17 kilograms) cubesat fitted with a magnetic docking plate. During the experiment on Wednesday (25 August 2021), ground controllers first remotely released a mechanical locking mechanism attaching the cubesat to the main 386-pound (175 kg) removal craft, Astroscale said in a statement. The two satellites were still held together by the magnetic system, which is responsible for capturing the debris.

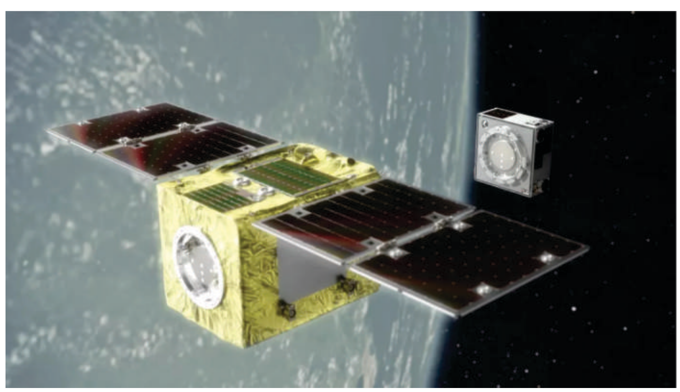
Nobu Okada
Founder and CEO, Astroscale

"This has been a fantastic first step in validating all the key technologies for rendezvous and proximity operations and capture in space"

We are proud to have proven our magnetic capture capabilities and excited to drive on-orbit servicing forward with ELSA-d.

A typical low Earth orbit mission's connectivity ranges from 5-15 minutes, with 1 or 2 ground station providers in a couple of locations. ELSA-d is performing complex demonstrations that have never been done before, and we need a very reliable and unusually long chain of connectivity to provide a constant real-time data feed throughout the demonstrations.

Source: space.com



PM Modi Address at the 76th Session of UN General Assembly

Prime Minister Narendra Modi addressed the 76th United Nations General Assembly (UNGA) on Saturday, 25 September 2021 where he spoke on a host of issues including extremism, open sea, and effectiveness of the United Nations. He also spoke on India's vaccine developments and invited global manufacturers to come and make vaccines in India.

"Today, every sixth person in the world is an Indian. When Indians progress, the development of the world also gets a boost.

When India grows, the world grows. When India reforms, the world transforms.

Science and technology-based Innovations in India can greatly help the world. Both the scale of our Tech-Solutions and their low cost are unparalleled.

With our Unified Payment Interface UPI, more than 3.5 billion transactions are taking place every month in India today. India's vaccine delivery platform Co-WIN, is providing digital support for millions of vaccine doses in a single day."

Prime Minister Narendra Modi informed the UNGA that India has developed the world's first DNA vaccine and added that the vaccine can be administered to anyone above the age of 12. "An mRNA vaccine is in the final stages of development. Indian scientists are also developing a nasal vaccine against Covid-19," PM Modi said.

"Today we all know that in human life, how important is technology. But in the changing world, **Technology with Democratic Values,** it is also necessary to ensure this.

Indian-origin doctors, innovators, engineers, managers, be it in any country, our democratic values, keep inspiring them to be engaged in the service of humanity. And we have seen this even during this corona period."

PM Modi further said that the Covid-19 pandemic has taught the world that the global economy be further diversified, adding that this is why the expansion of global value chains is very important. PM Modi said that the **Aatmanirbhar Bharat Abhiyaan** is "inspired by this sentiment".

PM Modi also spoke about the correct use of ocean resources. "Our oceans are also the lifeline of international trade. We must protect them from the race for expansion. The international community must speak in one voice to strengthen a rule-based world order," PM Modi said at UNGA.

"Under these circumstances, the whole world has to make Science-Based, Rational and Progressive Thinking the basis of development.

To strengthen the **science-based approach,** India is promoting **Experience Based Learning.** We have opened thousands of Atal Tinkering Labs in schools, built incubators and developed a strong start-up ecosystem.

PM Modi's address at UNGA High Impact Quotes on Deployment of Science and Technology

Today is the birth anniversary of Pandit Deendayal Upadhyay ji, the father of **'Ekatma Manav Darshan'** . 'Ekatma Manav Darshan' i.e. Integral Humanism. That is, the co-journey of **development and expansion from self to collective.**

Expansion of the self, moving from individual to the society, the nation and entire humanity and this contemplation is dedicated to Antyodaya. **Antyodaya is called where no one is left behind,** in today's definition.

With this spirit, **India today is moving ahead on the path of Integrated, Equitable Development.**

The '75 satellites' mission to launch student satellites into space was initiated by the ***Indian Technology Congress Association (ITCA)*** in collaboration with the ***Indian Space Research Organisation (ISRO)*** and other tech-space organizations.

According to the official website, the objective is to develop 75 student smallsats by 2022 in order to improve the communication efficiency. The initiative was inspired by the prime minister's '*Gaganyaan Space mission 2022*..

Expressing his views on the importance of a science-based approach for learning, PM Modi said, "*Regressive thinking and extremism is increasingly threatening the world. In these circumstances, the entire world will have to make science-based rational and progressive thinking the basis of their development programs.*"

Information is courtesy of ***Hindustan Times***

Development must be all-inclusive, all-touching, all-pervading, all-alible, this is our priority."

"In the last seven years, more than **430 million people in India have been connected to the banking system,** who were so far deprived of it. Today, more than 360 million people who could not have thought of it earlier have also got insurance coverage.

By providing free treatment to more than **50 crore people, India has connected them with quality health service. India has made 30 million pucca houses,** homeless families are now home-owners."

"Polluted water is a big problem not only in India but in the whole world and especially for poor and developing countries. To tackle this challenge in India, we are running a **huge campaign to provide piped clean water to more than 170 million households."**

"Big organizations of the world have recognized that for the development of any country, it is very important for its citizens to have property rights of land and house, that is, a record of ownership. In the large countries of the world, there are a large number of people who do not have property rights of land and houses.

Today we are engaged in providing **digital records** of their homes and land to millions of people by **mapping them with drones in more than 600000 villages of India.**

This **digital record is facilitating the access of people to access to credit –** bank loans, while reducing property disputes."

"India is becoming a democratic and trustworthy partner of the world for Global Industrial Diversification".

And in this campaign, India has established a better balance in both economy and ecology. You will definitely be proud to see **India's efforts on climate action** as compared to big and developed countries. Today, India is **moving very fast towards the target of 450 GW of renewable energy. We are also in the campaign to make India the world's largest Green Hydrogen Hub."**

To commemorate the 75th year of its independence, India is going to launch 75 such satellites into space, which Indian students are developing in schools and colleges."

U.S.-India Joint Leaders' Statement: A Partnership for Global Good (September 24, 2021)

Excerpts related to Space

The Leaders decided that the United States and India must continue and expand their partnership in new domains and many areas of critical and emerging technology – space, cyber, health security, semiconductors, AI, 5G, 6G and future generation telecommunications technology, and Blockchain, that will define innovation processes, and the economic and security landscape of the next century.

The Leaders reiterated the importance of sustainable capacity-building and noted that mutual technical assistance efforts to respond to cyber threats should be prioritized and increased, including through dialogues, joint meetings, training and sharing of best practices. They looked forward to the finalization of a Space Situational Awareness Memorandum of Understanding that will help in sharing of data and services towards ensuring the long-term sustainability of outer space activities by the end of the year.

Ref: https://pib.gov.in/PressReleseDetail.aspx?PRID=1762426

Lead Aticle

Space Committee ITCA

Space for Everyone and Satellites for Everyone

From the launch of the earth's first artificial satellite, Sputnik I, on 4 October 1957, space-based services have become an integral part of citizens' daily lives. Today, space technologies impact multiple touch points, including education, public health, medicine, energy, environment, information technology, public safety, consumer goods, industrial productivity, national defence, and homeland security, and has played a significant role in integrating societies and regions across the globe.

Space 1.0 heralded the introduction of the Global Positioning System (GPS). Industry analysts estimate that GPS satellites have generated approximately USD 1.7 trillion worth economic benefits since the technology was commercially adopted in the 1980s.

The advent of Space 2.0 systems, counting on innovations such as Artificial Intelligence (AI), Internet of Things (IoT), robotics and contemporary communication technologies, has made the use of space-based services pervasive, with many more countries and commercial organizations launching and operating satellites. As a result, it is anticipated that more than 40,000 small satellites expected to launch by 2030, deepening society's reliance on space-based assets and ushering in an era of innovative products and services.

With the culmination of the Cold War and increased cooperation between nation-states, an era of collaboration or Space 3.0 began with ambitious multinational programs like the International Space Station (ISS). While this provided new possibilities for emerging nations to join and contribute to space activities that were previously confined to a few countries and a few large private corporations.

Unlike in the Old Space Era, where government agencies were the sole source of funding and development, innovation in the age of New Space is based on the collaboration and partnership of public and private businesses, entrepreneurs, and academia. Today, Space 4.0 is emerging as a democratized and level playing field characterized by more public-private and private-private synergies and partnerships with the inception of numerous start-ups to medium-sized private organizations. Continuous space developments will undoubtedly play a significant part in tackling the present and next decade's pressing social issues and guarantee a healthy and sustainable future for the next generation.

Segmentation of the Space Sector

Space activities can be classified into sectors-national and homeland security (defence), civil and commercial. While the defence and civil sectors have been around for the last few decades, we see an upsurge in the commercial sector. In the commercial segment, all space-related endeavours are delivered by private sector businesses with the legal capacity to offer their products, solutions and services to private citizens, business entities and non-governmental customers.

A distinguishing aspect of New Space is that, while each sector has its own aims and assets, the sectors leverage and profit from a shared space industrial base, educated workforce, and infrastructure that has been built through time, with the majority of the funds coming from taxpayers.

Expansion of Space Economy

Another clearly evident tendency is that a large percentage of the profits gained in the space sector So far have come from the space-for-earth economy, which consists of goods or services created in space for use on Earth. The space-for-earth economy was primarily focused on satellite communication and internet services; earth observation capabilities; satellite positioning and navigation; and remote-sensing satellites, which collect data from energy reflected or emitted from Earth. However, there is significant contextual evidence to suggest that the day is not far off when we can envision a growing space-for-space economy where goods and services are produced and used in space, with SpaceX's recent accomplishments and those of Blue Origin, Virgin Galactic, and Boeing, putting people in space and ushering in a new chapter of private spaceflight.

It has been established that near-earth asteroids possess significant reserves of metals, minerals, and materials essential to electronics and the high-tech industry on Earth. In 2018, Luxembourg became the first nation to pass state legislation, granting private businesses the legal framework to extract resources from near-Earth asteroids. In the coming decade, we are likely to see new business cases such as mining the Moon or asteroids for material becoming viable with manufacturing in space becoming a reality.

Transformation of National Space Agencies

The space industry's transformation has necessitated that national space agencies such as the Indian Space Research Organization, the National

Aeronautics and Space Administration, and the European Space Agency transition from being the sole champions and investors to being one of many participants in a democratised national space sector.

The national space agencies, in addition to pursuing and progressing strategic programmes will need to play a role in structuring a conducive and progressive regulatory framework, promoting establishment and growth of the private sector, attracting foreign business while representing and articulating the nation's vision and strategy in the global comity of countries.

The proliferation of Small Satellites

Global technological advances, including high-quality semiconductors from the extremely price-sensitive mobile phone industry, 3D printing of parts, access to the spare capacity of large rockets through ridesharing, have helped grow the use of Commercial-off-the-shelf (COTS) high-performance and affordable-cost hardware for small satellites.

The standardisation of CubeSats and small satellites has facilitated the transformation of the satellite industry, with missions development costs dropping to fractions of the price of conventional satellites and development time reduced to about 8-12 months from the time the need is assessed to the time the satellite is placed in orbit. In addition, small satellite constellations can ensure continuous renewal of the satellite system, which translates to the delivery of optimum technological services at all times.

Use cases

Satellite communication is likely to play a significant role in the deployment of 5G and beyond, as a possible solution for ubiquitous coverage, reliable aerospace and maritime communication, remote or rural area coverage and back-up communication in case of national calamities and disasters. By 2025-2027, it is possible that there will be more than 75-100 High Throughput Satellite (HTS) systems using Geostationary Earth Orbit (GEO) and large constellations of Low Earth Orbit (LEO) satellites delivering Terabit per second (Tbps) internet capacity across the globe. We are also likely to see the proliferation of Internet of Things (IoT) devices, and these would be able to transmit data seamlessly without performance degradation issues.

"Precision agriculture" is the optimum and efficient use of resources, farm machinery and efforts made possible using precise position data. Constellations of nanosatellites and CubeSats will help farmers assess the health of the soil and crops, determining fertilizer needs and estimating yields. Using equipment with GPS receivers, farmers would be able to customize the application of fertilizers and pesticides to each location in their field and would avoid over application of pesticides and nutrients.

Satellite based services provide real-time and predictive information on fishing locations that can be geo referenced using GPS and monitor factors that influence fish movements including sea surface temperature and ocean colour.

Space-based technologies have played a pivotal role in promoting global health and have been used for understanding environmental triggers for the spread of diseases, monitoring disease patterns, identifying risk areas, and specifying regions for disease-control planning. Satellite communication has emerged as a critical piece of the nation's health information infrastructure. Applications of satellite technology include telemedicine which has been used effectively during the Covid-19 pandemic for medical professionals to examine and diagnose patients virtually and minimize in-person contact.

Contemporary technological advances including Artificial Intelligence, Machine Learning and Cloud Computing are enabling users to analyse large datasets of earth observation data in an accurate and efficient manner. Using these technologies, earth observation data is being analysed in real-time, enhancing the speed of response by Government and other teams.

Future is Now...

Small satellites, including CubeSats are a technological enabler, facilitating breakthrough innovations across all industries and sectors of the economy. Enterprises of tomorrow are likely to use CubeSats as building blocks and leverage the development of high-performance satellite payloads and subsystems to drive business value and growth.

While it is true that space technologies are developing at a faster pace than what policymakers and global citizens may understand, it is important that experts in downstream applications create adequate thought-leadership and technology focus group to convince Governments and industry associations about the need to create and maintain national spatial data infrastructure that can be made available for commercial exploitation. There is also an urgent need to build a framework to support research and development, capacity-building and data sharing.

SpaceTech applications provide over 99 percent of accurate weather forecasts.

UNITYSat is CubeSat - Single Card Satellite

Launched Successfully in ISRO PSLV C51 Amazonia Mission on 28 Feb 2021

Secretary General ITCA

Dr. K. Gopalakrishnan
Project Director
75 Student's Satellite Mission

Primary Mission

The UNITYSat is designed for it being a Technology Demonstration of Indigenously developed systems for nanosatellite applications.

Secondary Mission

- Experimental study of ultra-compact satellites in space environment
- Experimental LoRa Inter Satellite Communication
- Establishment of open-source satellite IoT network based on LoRa
- Testing indigenously developed CubeSat Deployer System.

UNITYsat consists of THREE Satellites, JITSat, GHRCESat and SriShakthiSat built jointly by TSC Technologies P Ltd, a students' start-up initiated/supported/mentored by Indian Technology Congress Association (ITCA). The UNITYSat is designed as a Joint Development by Jeppiaar Institute of Technology, Sunguvarchatram, Sriperumpudur (JITSat), G. H. Raisoni College of Engineering, Nagpur (GHRCESat) and Sri Shakthi Institute of Engineering and Technology, Coimbatore (Sri Shakthi Sat) as a Technology Demonstration Mission for studying the indigenously developed satellite subsystems at LEO such as the On-Board Command, Data Handling System, the Electronic Power System and the Communication System. NHCE Students' start-up, TSC Technologies Pvt Ltd, Bangalore and Committee for Space Program Development (CSPD), Serbia has initially provided technical assistance for the teams of consortium of these three colleges mentioned above. The entire process is mentored by senior scientists superannuated from ISRO with their generous motivation/encouragement and the proactive support of the Industries, such as Alpha Design Technologies, Karnataka Hybrid Micro Devices Ltd, New Tech Solutions, Kepler Aerospace and Micropack Limited who have come forward to hand hold the teams and providing necessary special technical/expertise/services/clean rooms/testing facilities etc along with educating/mentoring the team members. This mission has also tested the viability of the utilization of such systems in nanosatellite development.

This satellite is developed as a 0.35U SlimSat that enables Universities and Colleges to develop full- fledged Satellite Systems with an affordable cost/lesser cost when compared to the typical systems that need to be imported from companies like EnduroSat, Pumpkin etc.. The entire team has been trained at International Space University, Strausberg, France, Samara National Research University, Russia, Tel Aviv University and Technion at Israel, Tokyo University, Japan etc through ITCA's interventions and network in the past 2-3 years.

This SlimSat design, called UNITYSat is a 0.33U satellite that has the following general features:

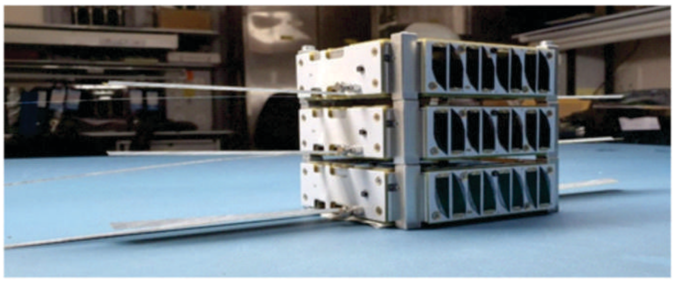
- 100MHz, Power Efficient ARM Cortex M4 Processors x 2
- Latch-up Protections and Automatic Reset Ics
- Critical Data Storage: 2MB FRAM + 4MB MRAM
- Low Iq (Quiescent Current) wide Input Voltage Range Switching
- Batteries Voltages between 1.8V to 5.5V
- Power Rails Available: 3.3V and 5V
- Maximum Power Output of 15.75 W
- Frequency Range of 435 - 438 MHZ
- Output Power (dBm) of 30dBm
- Rx Sensitivity is -137 dBm
- Bandwidth of 125 kHz

The UNITYSat is also designed to study the application of LoRa modems for inter-satellite communication by transmitting satellite beacon signals and having the other satellites in the mesh act as a relay and eventually transmitting it to a ground station. It is

study the application of LoRa modems for inter-satellite communication by transmitting satellite beacon signals and having the other satellites in the mesh act as a relay and eventually transmitting it to a ground station. It is also designed to operate on an open-source LoRa platform thereby giving access to anyone who wants to use it. The data will be encrypted but the key for decryption will be shared through the open-source platform called SatNOGS. This platform consists of hundreds of ground stations around the world. We are designing this satellite to be able to interact with all these stations.

This mission also includes the development of an indigenous CubeSat deployment system that will help reduce the weight of the satellite deployer. This will drastically reduce the cost for launching such nanosatellites.

Hardware Design Review is under Progress:
UNITYsat Team is at Newtech Solutions Clean Room



CubeSat/Single Card Satellite/UNITYsat is ready for Launch!
Demonstration of Inter-Satellite Communication

ITCA-TSC UNITYsat Team - After Successful Launch of THREE Satellites:
Team with Chairman Dr. K. Sivan, Secretary, Department of Space (DOS), Chairman, ISRO @ Satish Dhawan Space Centre (SDSC) – SHAR, Sriharikota.

UNITYSat (JITSat, GHRCESat & SriShakthiSat):

THREE Satellites Launched on 28 Feb 2021 by PSLV-C51 Amazonia Mission

Operational Status:

All satellites are Currently Operational

JITSat Data:

[SX1268] Data: 165:170: 97:37.00:35.00:36.00:38.00: 12: 16:255:255:END:

[SX1268] RSSI: -115.00 dBm

[SX1268] SNR: -11.50 dB

[SX1268] Frequency error: 1950.16 Hz

GHRCESat Data:

[Sx1268] Data: 165:187: 97:37.00:38.00:38.00:40.00: 13:201:255:255:END:

[SX1268] RSSI: -113.00 dBm

[SX1268] SNR: -12.70 dB

[Sx1268] Frequency error: 1750.25 Hz

Sri ShakthiSat Data:

[SX1268] Data: 165:204: 97:38.00:37.00:37.00:40.00: 12:208:255:255:END:

[SX1268] RSSI: -109.00 dBm

[SX1268] SNR: -13.75 dB

[Sx1268] Frequency error: 2425.45 Hz

NORAD IDs/COSPAR IDs:

JITsat: 47716/21015S

GHRCEsat: 47717/21015T

Sri Shakthi Sat: 47718/21015U

Current Orbital Parameters:

JITSat:

Apogee: 515.5 km

Perigee: 500.9 km

Inclination: 97.4542 Degrees

GHRCESat:

Apogee: 516.2 km

Perigee: 500.7 km

Inclination: 97.4561 Degrees

SriShakthiSat:

Apogee: 515.5 km

Perigee: 501.3 km

Inclination: 97.4537 Degrees

Orbital Elements/TLE:

OBJECT S (JITSat)

1 47716U 21015S 21179.15869541 -.00000070 00000-0 00000+0 0 9990

2 47716 97.4542 253.3386 0010644 227.8215 132.2524 15.21580094 18115

OBJECT T (GHRCESat)

1 47717U 21015T 21179.16289354 -.00000070 00000-0 00000+0 0 9990

2 47717 97.4561 253.3293 0011249 231.2650 128.8200 15.21500929 18221

OBJECT U (SRISHAKTHISat)

1 47718U 21015U 21179.16386204 -.00000070 00000-0 00000+0 0 9993

2 47718 97.4537 253.3253 0010342 235.8699 124.2095 15.21513384 18228

Thought Leader's Perspective

Dr. Mylswamy Annadurai
Distinguished Scientist
Director(Rtd)
ISRO Satellite Centre

Private Industries Participation in Indian Space Programme

After three industrial revolutions the emergence of space programme that enabled the humanity to make use of the space as a vantage point for the pursuit of science and societal applications has driven to hugely invested infrastructure and human talent in the hands of few developed countries. However, a visionary approach by Dr Vikram Sarabahai followed by Prof Dhawan led to the initiation and growth of Indian Space programme to have a national space systems for the societal benefits.

Today Indian space programme spear headed by ISRO (Indian Space Research Organisation) has grown leap and bounds. During it's 60 year long journey ISRO has acquired end to end capability to build, launch and operate all type of missions for earth observation, communication, navigation, meteorology, science missions and now it has graduated itself to embark on missions like Chandrayaan, Mangalyaan, Aditya and Gaganyaan. Required infrastructure and human expertise have been acquired indigenously. Government of India has made huge investments to build the state of the art infrastructure facilities at various ISRO centres across India with larger capacities and capabilities.

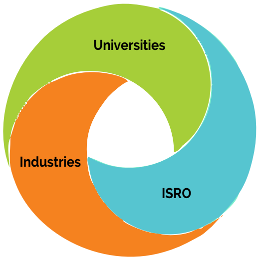
While infrastructures have been enhanced the requirement of more and more satellites for the new and increased societal needs like digital India, E-governance, emerging internal and external security threats are also going up. Additionally possibility of India's support for the space programmes of friendly countries is also slowly and steadily emerging. This along with limited manpower at ISRO leads to the lack of adequate manpower to meet the additional requirements.

Foreseeing a possible crisis in the manpower inadequacy, ISRO has sought the help of external industry to have a near parallel line up for an end to end satellite making process flow in a structured way. ISRO did a supportive hand holding for the select group of industries from components screening to satellite integration and testing. The teams that successfully went through the drill are given the due opportunity to build a parallel process line to make the satellites that are repeatable and routine in nature. Since 2016 responsibility of making some of the navigation, earth observation and communication satellites has been given to the selected and trained man power from the external industries at ISRO facilities. This has led to an ecosystem of skilled manpower from external industry to make satellite systems end to end.

Having seen the success in bringing the external industry for satellite making, now ISRO has embarked to identify external industry partners who could learn with ISRO team and acquire the capability to make and prepare for launch ISRO's work horse PSLV to start with and later graduate to GSLV M-III.

While ISRO may hand hold the industry partners at the initial stages, gradually it is expected the industry partners could equip themselves to bid for satellite and launch vehicles for both national and international customers under the guidelines of national space policy. Such an eventual scenario has all the potential to create a vibrant and competitive space industry within India.

An ecosystem of fully geared up space industry to make the satellites and launch is expected to provide an affordable space transport system along with innovative solutions from the space in the areas of communication, navigation and earth observation. This is expected to provide enough room for ISRO's R&D manpower to concentrate their efforts towards newer technologies and new frontiers in space while leaving the burden of making more and satellite launches that are commercially competitive and lucrative to the industry. To source the required manpower with adequate skill sets and aptitude, it is expected that both ISRO and Industry entering into a healthy competition to lure the bright students from academia by some challenging and attractive offerings. Such a win-win-win situation along with the post pandemic new norm of countries shying away from China has a potential to trigger a spiralling growth for Indian space industry along with academia.



Collaborative Student Satellite Development

Joint Development between Institution and TSC with international organizations - WCRC, ITCA, UNISEC INDIA, and CSPD - SERBIA.

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TSC Technologies Pt. Ltd., Bangalore

75 Students' Satellites Mission

The ambitious Industry-Academia Collaborative Project

An Initiative of ITCA

ITCA envisioned 75 satellite missions, that has been thoroughly planned, designed, constructed, launched, and monitored by students from academic institutions to commemorate India's 75th anniversary of independence (1947-2022). Under the leadership of ITCA, this ambitious mission was conceived in association with prominent space scientists and TechSpace enterprises worldwide. In addition, the teams collaborated assiduously with several professional organizations from across the world, including TMISAT-Israel, Israel Aerospace Industries, CSPD-Serbia, and UNISEC-Japan, to bring this vision to life and carry out the operation within the time frame available.

The Vision

To exploit SPACE's enormous potential through the capacity development of student-built SmallSats

The Mission

The primary objective is to leverage student SmallSat development to broaden skills and standards in a range of space technologies, engineering, and applications. In addition, students from diverse universities, institutions, and schools will work with commercial space-related companies and R&D institutes to develop and deploy 75 Satillites, therefore increasing the nation's CubeSat ecosystem and skills competency.

The Benefits

The work is undeniably complex and global in scope, necessitating a broader range of abilities and skills. Developing and launching 75 small satellites, alone or even as part of a constellation system, will improve the efficiency of communications, monitoring, and telemetric evaluations. Which will contribute to a wide range of applications such as disaster mitigation, forestry, fisheries, healthcare, education, agriculture, and solutions that are boundless everywhere, and are for everyone.

Engineer Your Satellite (EYS)

EYS is an ITCA up-skilling and certification programme that will aid in the stunning initiative of 75 Students' Satellite Mission 2022. The EYS activities are intended to improve faculty and student skills while also successfully contributing to their envisioned ambitious project missions of student satellite development, which will precisely progress the country's Sat-ecosystems.

ITCA has carefully fostered a range of capacity building programmes, including overseas trips, practice-based learning, on-campus skilling, workshops, and among others, to maximize participants' learning outcomes for more considerable contributions to Sat project missions

.EYS planned exploratory tours to Israel, Serbia, and Russia are tailored to industry standards for addressing immediate competency-based Space skill improvement in pursuit of mission long-term success.

75 Student's Satellites Mission Prospects

75 Students' Satellites Mission - The Journey

The decision was made during the ITC 2017 in Bangalore in September 2017 to institutionalize Indian Technology Congress' activities.

The ITCA Space Team paid a visit to **Mr Ofir Akunis, Israel's Minister of Science and Technology,** in the **Israeli Parliament** in June 2018 to establish the India-Israel Space Partnership.

In September 2018, the **"75 Students' Satellites Mission 2022"** was unveiled at ITC 2018.

Providing an NSIL-ISRO launch service to Israeli schoolchildren-developed Duchifat-3 satellite.

UNISEC India began operations in 2018.

The first International Programme on Students' Satellite Mission was held in September at ITC 2018.

The **75 Students' Satellites Consortium** was launched in October 2018.

November 2018 marks the start of the second International Program on Student Satellite Missions.

A National Seminar on New Space - As Era of Small Satellite: Opportunities and challenges in April 2019.

WCRC was established to support and encourage university participation in the field of space engineering - 2019.

Third International Programme on Students' Satellites Mission at ITC 2019 in September 2019.

In October 2019, **ITCA's teams** took the **first** and **second** places in the **Serbia International CanSat / Rocketry Competition** and the **UNISEC Global Special Jury Awards.**

Launching of Duchifat-3 through NSIL in December 2019

75 Students' Satellites Consortium earned the **ARISS SSTV Award** from the International Space Station (ISS) for photographs transmitted by the ISS when it sailed over India utilizing the Ground Station constraining December 2019.

Visits of Israeli teams to discussion for 75 Students' Satellites Mission 2022-February 2021.

Successful Launch of **UNITYSat (3-in-1 Satellites)**-February 2021.

ITCA's **Global Technology Cooperation Initiatives** with Israel-April 2021.

Success Meet of UNITYSat (3-in-1 JITSat, GHRCESat and SriShakthiSat) in June 2021.

First government high school in India to develop a satellite: Dr. C N AshwathNarayan, Karnataka's Minister of Science and Technology, announced at Bengaluru on 8 July 2021 that the Government Boys High School in Malleswaram, Bengaluru will be launching a student-built satellite in August 2022, and with this, will position itself as the first government high school in India to develop a satellite.

International event on **"Satellites for Everyone and Space for Everyone"** at ITC-2021, September 2021.

Our Hon'ble Prime Minister Shri. Narendra Modi Ji's address to the **world leaders** at the 76th **Session of United Nations' General Assembly** on Saturday, 25 September 2021 referencing the **"75 Students' Satellites Mission 2022".**

Systems Engineering and SmallSats

To Enhance Success of Small Satellite Mission

Srinivas Durvasula
Business Manager
Indian Technology
Congress Association

The New Space Era has been characterized by the paradigm shift to launching of small satellites characterized by reduction in the development time, lowering of costs and increasing deployment of miniaturized electronic components resulting in a smaller form factor. With this, access to space that was hitherto exclusively reserved for large companies or national space agencies has been democratized and made open to organizations of all sizes.

The uniqueness of Small Satellites (SmallSats) is that the development time in many cases is about a year (12 months) from the time the need is articulated to the time the satellite is placed in orbit. Old Space that was characterized by risks of obsolescence and possibility of failure, has given way to constellations of SmallSats which ensure that a consistent state-of-the-art system is maintained, always ensuring delivery of optimum technological service.

While SmallSats have lowered the barrier to entry to amateurs from academia and professionals from industry and research institutions, there has been an increasing pressure on the participants to ensure success in the first launch attempt itself. This has led to the replacement of ad-hoc practices by first-time practitioners (characterized by lower reliability and greater chance of failure) with structured processes and practices that guide development teams through a formal project lifecycle, from concept to retirement.

Work is currently in progress to develop project lifecycle models for SmallSats and is based on the understanding of systems engineering principles with the objective of reducing ad-hoc development efforts in smallsats. A unique feature of all project lifecycle models is to ensure that engineering activities are performed throughout the lifecycle in a manner to ensure higher missions successes for space missions (known as mission assurance). The engineering activities across the project lifecycle are organized into five phases: concept, preliminary design, critical design, verification and validation, operations and disposal.

While typical space missions may require the development of the space,ground, and launch systems; smallsat missions do not require thedevelopment of all three systems. Smallsats are typically launched assecondary payloads and are launched out of containers (also called deployers), and do not require thedevelopment or performance of launch activities.

In addition to the design of the space and ground systems, the satellite development program is stitched through the project management tasks. These tasks are typically organized by the project manager and include the following activities: identifying roles, responsibilities, tasks while organizing team personnel, developing schedule that shows the entire lifecycle, developing and managing the budget, identifying facilities required for development and operations and determining the required compliances and approvals,and finalizing launch opportunities.During scheduling, it is suggested to identify the long lead time items because most Commercially Off the Shelf (COTS) components have 3-6 months lead time and must be accounted for. The cost budget is also updated with the detailed design and the budget must include non-material costs. It is important to factor contingencies, both in the schedule and the budget.

On the successful completion of the system level tests, it is important for the project teams to assess the fulfilment of each requirement identified in the requirements document and in the requirements verification matrix. The project team should complete a flight readiness review (FRR) with external reviewers to establish the readiness for launch. After a successful FRR, the project team packages the satellite and delivers the satellite to the launch provider for its journey into an orbit.

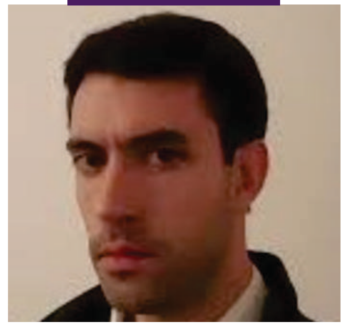
The final phase of the SmallSat mission involves the post launch operation. As part of the mission operations, the SmallSat team will implement a data collection, storage, and distribution scheme, where the payload data along with satellite health data are gathered, stored, and downlinked to the ground. Commands from the ground station are uplinked to the SmallSat as may be necessary.

Management innovations are needed by the smallsat project team leadership to exploit the potential advantages offered by the small satellite approach. It is essential for the team to adopt an agile and less hierarchical approach than is typical for larger missions.

To conclude, Systems Engineering is a multidisciplinary and collaborative engineering approach to design, develop, integrate, and validate an optimum engineering solution across the development lifecycle and achieve the stakeholders' expectations. It is essential that nanosatellite projects adopt a suitable Systems Engineering process so as to avoid re-work, schedule overruns, lower costs, and also reduce system complexity.

Global Practitioner

Steps to Space



Dušan Radosavljevic
Founder and Head,
Committee for Space Programme Development (CSPD), Serbia
Founder, World CanSat/Rocketry Championship, Serbia

This topic is precisely the main reason why the **Committee for Space Programme Development (CSPD)** was founded, i.e. the main goal of the CSPD is reflected in the title of this topic. This is what all enthusiasts face at the beginning, how to reach the goal, how to achieve it taking into account the problems that already exist at the very beginning. The CSPD wanted to show by its example, and help others, that it is possible to achieve this goal and to in some way define that path (steps) so that others can use it. Therefore, the CSPD is not a national organization, it was only founded in Serbia, but it is international, both in terms of membership and in terms of programs/projects, i.e. activities. The desire to do something, for Serbia and the whole region to be part of the World and in this area, to go to Space was simply too great, but also a problem. However, a rational understanding of the circumstances was important and the application of an adequate approach and tools accordingly. The approach was international, and the main tool was of course education, i.e. applied education.

Today, the Space is not technically inaccessible to many countries for economic reasons, but for systemic reasons. Conflict and post-conflict regions, disordered and unstable systems, manipulation with everyday problems, etc. are just some of the reasons why the voice of those who want to do a little and a lot in this area is not heard. This area, unlike others, earthly, is selfless. Everything you do about the Space concerns everything and everyone, it concerns every inhabitant of a spaceship called Earth.

CSPD has also gone through these problems, but during hard work and effort it has proven to be an excellent tool for changing the consciousness of people in post-conflict regions, i.e. for Peace/Cooperation among people no matter what crisis they face because thinking is much broader. Space diplomacy represents a different approach to change people's thinking, especially decision makers. Sometimes it is necessary to do something much bigger in order for the problems at much lower levels to finally be solved.

FIRST Step to Space

Define a Strategy for the capacity building and human resources development in the field of Space Engineering for all levels of education!

Today, there is much greater potential in terms of enthusiasm in countries that are just entering these waters. It takes much less investment to do something big, because money is still not a main motive. It sounds paradoxical, but a situation like this is good for the progress of humanity. Of course, countries like this and small players cannot be compared to big players and those who have been in the game for a long time, but there is definitely a much greater driving potential. A lot of theory is taught at universities, students after graduation are not sure what they know and what they do not know, they lack vertical education, hands on. Space Engineering programs, such as the CanSat/Rocketry program, are designed to provide students with answers to these questions and to continue to work on themselves concretely. This program is a direct connection to the Space in some way because it is a simulation of a real Space mission. After this the next step is the Space. Serbia is the country where CSPD was founded, a country completely new in this field, and CSPD is the only organization that deals with Space Engineering. So all mentioned problemswere present. We have no choice but to start slowly, from the beginning, from scratch. The knowledge gained abroad and online, as well as the fundamental knowledge acquired in the country, we used for this pioneering endeavor. We have defined the Strategy for the Space program development in the country, i.e. for the capacity building and human resources development in the field of Space Engineering. The interdisciplinarity of this field has enabled us to include experts from various fields: engineers, pilots, radio amateurs, astronomers, space lawyers, etc. The Strategy has covered all levels of education, that is, from kindergarten to higher education. We have defined programs/projects by levels of education, as well as their complexity. We applied a step by step process.

In line with the CSPD's Strategy for capacity building and human resource development in this area, certain Educational/developmental programs have been in place for several years:


CanSat/Rocketry Program
(All Levels of Education + Competitions)


Stratospheric Balloon Launch
(Secondary and University Level of Education)


PocketQube 3D Printed
(University Level of Education)


CubeSat "hybrid"
(University Level of Education)


Ground Station Program / Satellite Communication Program
(Secondary and University Level of Education)


Modeling for 3D Printing and Testing of New Materials/filaments
(University Level of Education)

During the International CanSat/Rocketry Competition in Serbia, our Rockets were used, and a three-stage Rocket for flight into the Stratosphere is currently under development.

We also use Water Rockets for educational purposes. These Rockets turned out to be most suitable for teaching students in the elementary and secondary school and it was one of the disciplines of the competition.

The CSPD constantly improves existing and apply new programs/projects in cooperation with partners from Serbia and abroad to achieve the defined goals.

SECOND Step to Space

Define basic and realistic applicative activities (Programs/ Projects) that follow the Strategy for capacity building and human resources development in the field of Space Engineering!

In line with this step, the CSPD has a number of applicative projects/ programs:

THIRD Step to Space

Establish a strong *Domestic Cooperation!*

- Elementary Schools
- Secondary technical schools and Gymnasiums
- Higher education institutions (Universities and Colleges)
- Aviation Association of Serbia
- Radio Amateur Association of Serbia
- Aero Club Sremska Mitrovica
- Governmental bodies (Agencies, Accredited laboratories, Testing facilities etc.)
- Private entities and industry

Today, Primary schools, Secondary technical schools and Gymnasiums and Higher education institutions from Serbia are actively cooperating with the CSPD.

For the needs of realization of its activities, the CSPD made a strategic cooperation with the Aero Club Sremska Mitrovica and established the Aerospace Center at the Airport Veliki Radinci. In this Center CSPD's engineers carry out activities of development and testing of equipment (Rockets development and testing, Rocket launch, Antenna development and testing, Components development and testing, etc.), then activities related to education, trainings, competitions, etc..

As far as the educational process is concerned, it is very important to understand that the involvement of both lecturers and students is equally important and encouraging their creativity without much conditioning. They need to be taught the essence and insist on creativity. The goal is for everyone to have fun and at the same time to learn and get ideas, which are actually the true motivation. From the beginning, emphasize the interdisciplinarity of this area and teamwork, i.e. the equal importance of each person/member.

FOURTH Step to Space

Establish even stronger *International Cooperation!*

- India (Strategic Partnership), Italy (FEES), Russia, Hungary, Mexico, Tunisia, Ghana, Greece (SatNOGS), Japan, Spain, Portugal, Brazil, Peru, Canada, Saudi Arabia, Kuwait, Egypt, Kenya etc. (more than 60 countries)
- UNISEC Global
- UNDP
- UNICEF
- ARISS
- Advice: If you can help someone in another country do it without monetary compensation, build trust and a network, you will automatically expand your influence and make a strategic partnership that is actually a win win situation. Together you are stronger, together you will easier get funding and achieve goals. When you help others you automatically get a friend and ally, especially if you use this as a tool for re-cooperation in the post-conflict region (CSPD helps and Montenegro and Bosnia and Herzegovina). No one should be selfish, but open. This commune is too small, open cooperation is the only way to develop it in a sustainable way.

Global Practitioner

Justyna Pelc
Co-founder
Innspace
Poland

Polish Satellite Industry – Growing Market

The Polish space sector is relatively young. Poland joined the European Space Agency in 2012, and the Polish Space Agency was established in 2014. The space sector has only been developing in Poland for less than a decade. So what does it look like today?

Poland's accession to ESA had a huge impact on local businesses. They were able to participate in ESA tenders, also on preferential (during the first years) terms. It had a huge impact on the great boom and the creation of many startups dealing with space projects.

Today, years later, it can already be seen that certain specializations have emerged in the local space sector. One of the fastest growing sectors is the satellite sector. It also has a lot to do with the mission of the Polish Space Agency: "in 2030, the Polish space sector will be fully competitive on a global scale in selected areas and will be able to ensure Poland independence in access to satellite data and its application". As you can see, the satellite industry is one of the top priorities.

What does this part of the sector look like in Poland?

Very beginning of Polish Satellites Sector

The first Polish satellite was created by students and was called PW-SAT. The design in the 1U standard was to test an innovative system for deorbiting small satellites. The project was successfully launched and placed in orbit in 2014. Another interesting project was called BRITE. Bright-star Target Explorer (BRITE) is a program of the Canadian-Austrian-Polish consortium, whose goal was to create a constellation of nanosatellites capable of observing stars brighter than the Sun. Polish part was represented i.e. by Space Research Center of the Polish Academy of Sciences, which was responsible for mechanical design of 2 satellites – Lem and Heweliusz. They were launched in 2013 and 2014.

Development of this Industry

During the next year, other student satellites were launched – PW-Sat2 and KrakSAT, and more are being prepared (PW-Sat3, WroSat). The commercial market started to develop as well. It is worth to present companies like SatRevolution, Creotech or KP Labs.

Launching in June 2021, STORK is the innovative shared platform with Earth-Observation capabilities. It was made by Polish company SatRevolution, which currently builds the REC (Real-time Earth-observation Constellation) satellite constellation planned for 2026, which will ultimately consist of 1500 observation satellites. Creotech is the fastest growing Polish operating company in the space sector. They are working now on HyperSat or Eagle Eye satellites.

KP Labs is responsible for Intuition-1 mission. It is a satellite mission designed to observe the Earth using a hyperspectral instrument and an on-board computing unit capable of processing data using neural networks (artificial intelligence) in orbit.

Innovative solutions

One of the most interesting solutions was designed by ICEYE. ICEYE is a Polish-Finnish company, building a satellite-based service to provide the world with access to near-real-time imagery from space. Their synthetic aperture radar (SAR) instrument can capture images through clouds, darkness and other obscuring elements, making it more reliable for operational use than optical camera systems.

Conclusions

That's just a few examples of Polish satellite sector solutions. This industry is growing fast in Poland and we can be sure to see more companies and projects related to this sector.

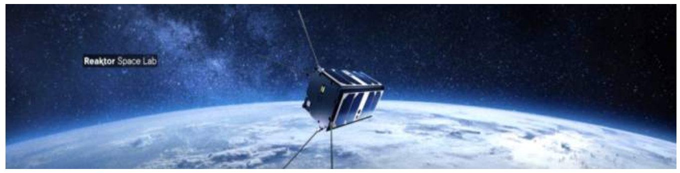
Satellites encompass the whole world, enabling high-capacity communications and transmission over vast and inaccessible areas such as deserts, mountain ranges, islands, forests, and wetlands.

The first 75 GHz Signals are sent from Space

The W-Cube smallsat is the first satellite that ESA has ordered from Finland and is part of ESA's ARTES project, which is coordinated by Joanneum Research in Austria. Reaktor Space Lab developed and manufactured W-Cube's satellite platform. VTT designed, manufactured and tested the radio beacon system of W-Cube together with Germany's Fraunhofer IAF. The satellite signal is measured at both the main measuring station in Graz as well as a corresponding station at VTT in Espoo, Finland.

The satellite is now modelling, for the first time ever, how a 75 GHz signal can penetrate the Earth's atmosphere. This opens possibilities for the use of the high millimeter wave frequency range in communications satellites in the future.

A new frequency range and additional capacity will be needed already in the next few years when the number of data communication satellites increases and big flocks of satellites such as Starlink operated by SpaceX are deployed.



The penetration through the atmospheric layers by the signal needs to be understood before the frequency range can be used. W-Cube's dual frequency radio beacon system sends a 75 GHz signal through the Earth's atmosphere to the measuring ground stations.

W-Cube was launched into space on June 30, 2021, from Cape Canaveral, Florida, on a SpaceX Falcon 9 launch vehicle as one of the satellites on the Transporter 2 mission with 88 additional satellites. W-Cube was placed into orbit on July22, 2021, and the first contact between the satellite and the RSL ground station was established 22 to 23 July.

Source: smallsatnews.com

SpaceX Dragon Carries GITAI Robotic Arm to the ISS

A SpaceX Dragon cargo resupply spacecraft docked with the International Space Station on Monday, carrying more than 4,800 pounds of science experiments, crew supplies, and spacecraft hardware. The ISS confirmed contact and capture at 10:30 a.m. ET.

The cargo Dragon was launched on SpaceX's 23rd Commercial Resupply Services (CRS) mission for NASA at 3:14 a.m. ET on Sunday on a Falcon 9 rocket from the Kennedy Space Center in Florida.

The Dragon delivered a robotic arm developed by Japanese company GITAI. This robot will conduct demonstrations of general purpose tasks in the Nanoracks Bishop Airlock ISS module. GITAI is working to develop robots that can perform tasks in space and the demonstrations that this robotic arm will conduct will be a key development for the company.

In addition, the Dragon carried experiments that will research issues including the effects of microgravity and space radiation on the growth of bone tissue; vision problems known as Space-Associated Neuro-Ocular Syndrome (SANS); and stress in plant growth in microgravity conditions.

Source: satellitetoday.com

The UNISEC

Global Consortium of Universities for Space

UNISEC-Global was established in 2013 as an international non-profit, non-governmental organization comprised of Local Chapters (LCs) around the world which expands on the success of UNISEC-Japan in organizing a consortium among Japanese universities promoting practical space engineering activities.

We started UNISEC-Global activities with a desire called "Vision 2020-100" which states: "By the end of 2020, let's create a world where university students can participate in practical space projects in more than 100 countries." Using this as a driving principle towards achieving our vision, we have coordinated practical space development activities such as; forums, technical competitions, and training programs for university students, researchers, professors, and private/public sectors. Our primary objective is to help create a world where space science and technology is used by individuals and institutions in every country, rich or poor for peaceful purposes and for the benefit of humankind .

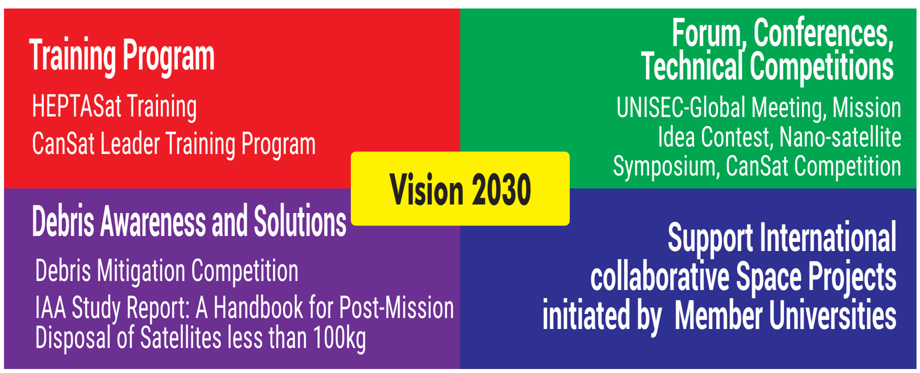
In 2017, UNISEC-Global was accepted as a permanent observer at the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). The key principle of 2030 Agenda proposed by UN is "No one will be left behind." Thus, "Vision 2020-100" was revised to "Vision 2030-All" which states: "By the end of 2030, let's create a world where university students can participate in practical space projects in all countries."

Although there is still much work to be done towards achieving the goal of realizing a world where access to good space education is not dependent on the geographical circumstance of birth, as of August 2021, UNISEC-Global now consists of 21 Local Chapters, with Points of Contact in 54 countries/regions exploring the possibility to establish their own regional UNISEC Local Chapter.

2. UNISEC-Global Activities

Vision 2030-All may sound too ambitious and not realistic at all, yet history and facts indicate otherwise. Only 20 years ago, very few people believed that university students could design, build, launch, and operate satellites, but we now commonly observe university students, sometimes even high school students, working on satellite projects all around the globe. Thus, realizing our vision could become achievable should our activities successfully spread among universities of non-spacefaring nations. It is good news that there are higher education organizations such as universities in almost all countries.

Let me introduce how we are trying to realize the vision.



Ms. Rei Kawashima
Secretary General
University Space Engineering Consortium (UNISEC) Global
Japan

2.1. CanSat Leader Training Program (CLTP)

The CanSat Leader Training Program (CLTP) is a capacity building program in space engineering offered by UNISEC-Global. CLTP was established in 2011 by UNISEC-Japan through a grant from the "Funding Program for World-Leading Innovative R&D on Science and Technology" (FIRST Program) enabled UNISEC-Japan to spread its mission of "support, promote and facilitate practical space projects at university level" to other countries. The program is led by UNISEC-Japan in cooperation with its member universities. UNISEC-Global acts as an information switching board to provides necessary information to its LCs and, in return, to UNISEC-Japan with possible candidates for CLTP. Local Chapters are encouraged to help organize their own CLTP in their regions. The CLTP program has since become affiliated to UNISEC-Global upon establishment. CLTP was offered in ten cycles in Japan until Aug 2019.

HEPTA-Sat training at CLTP where students adopt a systems engineering approach

HEPTA-Sat, a newly developed training tool, which is analogous to a CubeSat, has been employed in CLTP instead of CanSat to make the training more effective since 2017. Figure shows HEPTA-Sat training in CLTP held in August 2018.

2.2. Mission Idea Contest

Mission Idea Contest (MIC) was established in 2010 to provide aerospace engineers, college students, consultants, and anybody interested in space with opportunities to present their creative ideas and gain international attention. The primary goal of mission idea contest is to open a door to a new facet of space exploration and utilisation.

In past contests, we observed MIC's positive aspects. Firstly, a MIC provides good training opportunities as a capacity-building program. As a MIC does not require significant financial resources, students can participate without hesitation. If they are selected as a finalist and cannot afford travel for their final presentation, they can also make a video presentation. Secondly, a MIC offers a chance to involve professional researchers and scientists in mission design using micro/nano satellites. As a micro/nano satellite provides limited power and function compared to larger satellites, trade-offs have to be carefully considered and choices should be made not to compromise the mission objective. The challenge of a MIC provides participants valuable experience in engineering and design. Thirdly, a MIC can function as a catalyst to make a difference in the real world. With a MIC opportunity, many professional satellite engineers, including students, can start to weigh up their options for realistic action to achieve their goals using micro/nano satellites.

As of 2021, MIC is in its 7th iteration which focused on deep space science and exploration with nano/micro satellites. It is the first time that contestants are required to design a deep space science and exploration mission. It is challenging for those with no experience and knowledge of such missions to propose a mission idea. Thus, we tried to attract diverse participants, including non-space faring countries, by offering free online lectures. Accordingly, two national competitions with deep space missions took place in Thailand and Costa Rica to select the candidates for the MIC7. Also, a support group that consists of young researchers of deep space exploration helped the participants by giving feedback. In the 1st round of selection, ten finalists were chosen. Finalists are required to submit a full paper and deliver a presentation to take place on November 13th, 2021.

UNISEC-Global is committed to contribution to Sustainable Development Goal 4 (Education) and will continue to work on it in deep space mission.

2.3. UNISEC-Global Meeting

The UNISEC-Global has facilitated an annual meeting since 2013. It provides a forum for technical competitions and organizes group discussion sessions by forming several groups based on topics. Student sessions are planned and managed by international student representatives. The meeting is also a place to discuss about current and future Local Chapters.

Previous meetings have been held in Japan, Bulgaria, Italy, and France so far with plans for the 2020 meeting to be held in Istanbul, Turkey, but the COVID-19 pandemic situation forced us to postpone it. However, the pandemic gave us a chance to transform from an annual in-person meeting to a monthly virtual meeting allowing us to provide a free and accessible format, with prominent speakers, interactive activities, and updates on UNISEC-Global's various chapters worldwide. UNISEC-Global envisions to make space science and technology available to everyone around the world, through the development of an environment promoting the free exchange of ideas, information and capabilities related to space engineering and space applications, with a specific attention for young people in developing and emerging countries.

3. UNISEC-Global Initiative on Government Policies in Support of Space Education

This year initiated a project aiming to promote virtuous governmental policies in support of space education. Space Education is defined as any form teaching, training, or capacity building, at any relevant level. It includes formal education from primary, secondary up to post-graduate levels, as well as vocational training, science and technology communication to the general public, in sum anything that can contribute to raising awareness on the critical importance of space technologies in our lives.

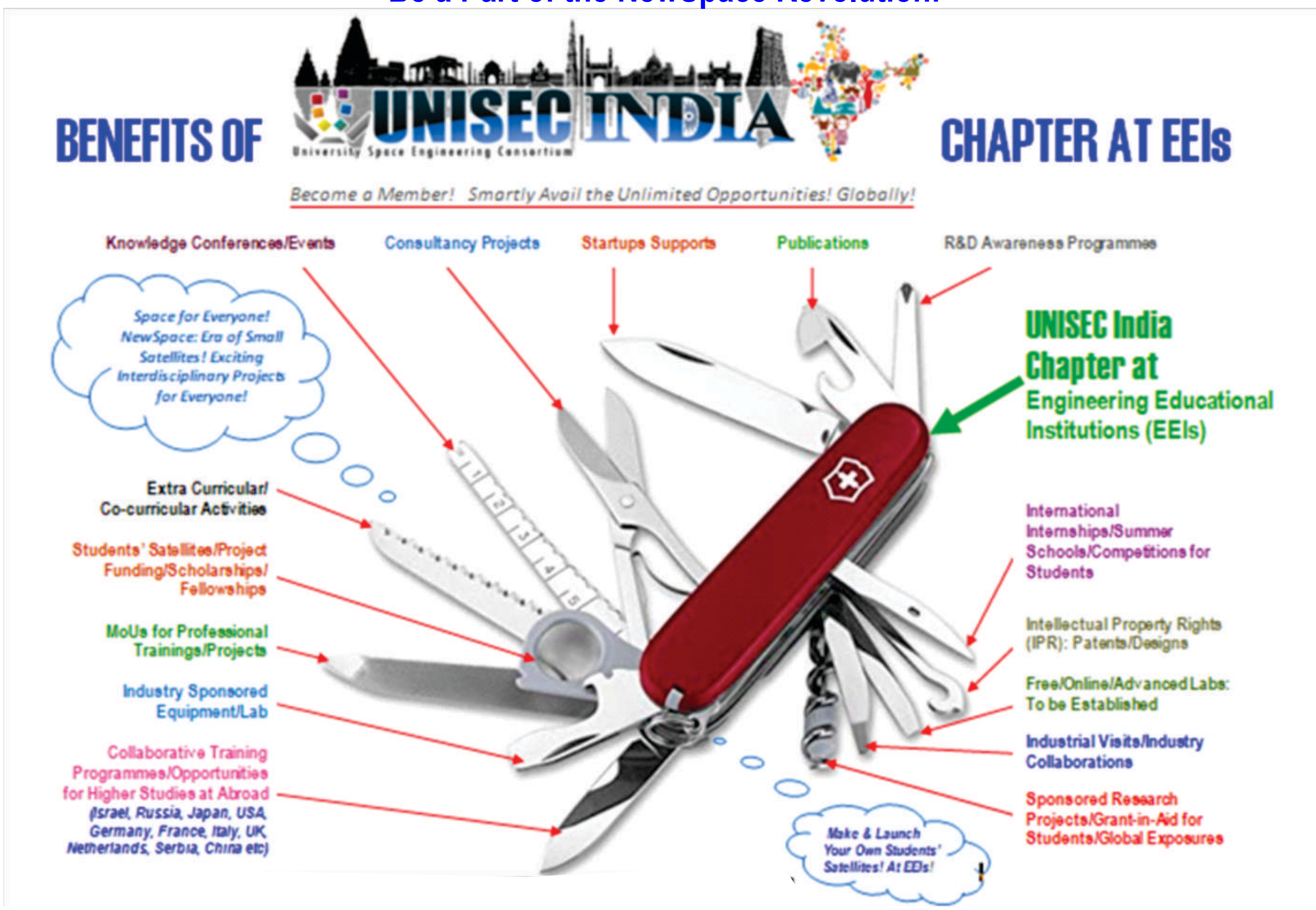
It will mostly consist of two research items:

(1) collecting and analyzing existing policies worldwide and acknowledging best practices, and (2) with our network of research partners, devising and proposing innovative policies in support to space education, from modest ones requiring only agency- or ministry-level decisions, to more ambitious ones requiring parliamentary work.

The concrete outcome of the project will be a report, revised and published annually in order to monitor the evolution of space education policies worldwide.

UNIVERSITY SPACE ENGINEERING CONSORTIUM (UNISEC)

Space for Every One! Era of Small Satellites! Students' Satellites!
Be a Part of the NewSpace Revolution!



- Create Opportunities for Exciting Interdisciplinary Students' Satellites Projects at Your Campus!
- Establish Students' Chapter at Your Institution! and Avail Institutional Membership of UNISEC India Free!
- Avail the Opportunities of Your Institute being Awarded for the Largest Chapter in India and World!
- Posses Functional Class Room Satellites for Better Learning of Systems Engineering!
- Avail Benefits of International Events to be held at Japan during December 2019!
- Avail Opportunities for Global Students' Satellites Competitions!
- Avail Opportunities for Your Students/faculty Members at Summer/Winter Schools at Israel, Russia, Japan, France, Germany, Italy, UK, Canada and USA!

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To become member download Application Form: https://drive.google.com/file/d/1dREbZHsswWaP8zaDH2_PSh9wTwKB8vRu/view

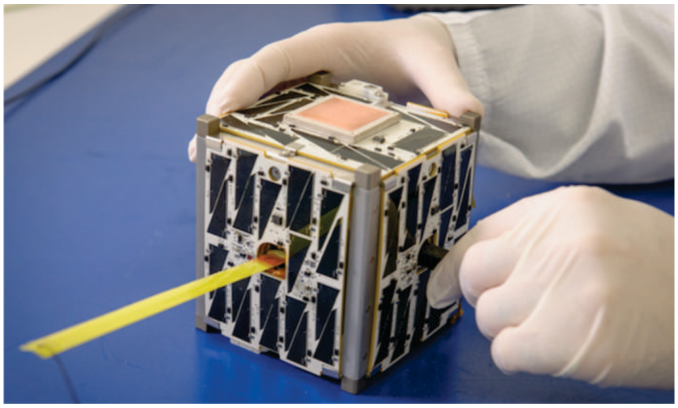
Free Nanosatellite Launch

Arianespace announces Competition

Arianespace announced April 14, 2021 it is organizing a contest open to startups, labs, and universities for a free launch of a nanosatellite on a future rideshare mission, likely on an Ariane 6 or Vega rocket.

Arianespace contest is open to startup companies, research labs, and educational institutions.

Other rocket companies, such as United Launch Alliance and Firefly Aerospace, have held similar competitions to launch educational and research payloads for free. The European Space Agency and NASA also have programs where the agencies pay for the launch of experimental university-built CubeSats.



The company's first dedicated rideshare mission launched from French Guiana last September on a Vega rocket. The Vega rocket debuted a new carrying structure to accommodate 53 satellites on a single mission, a record for a European space mission.

Arianespace plans to conduct more rideshare missions, either by filling excess capacity on a rocket with small satellites or grouping large clusters of smallsats to share a launch.

Europe's next-generation launcher, the Ariane 6, will also be capable of rideshare missions. Scheduled to fly for the first time in 2022, the Ariane 6 will haul much heavier cargo to orbit than the light-class Vega launcher, including missions targeting higher altitudes.

Source: spaceflightnow.com

StudentSats - The Future

Transforming Engineering Education

Student-built space missions have been successful in providing students an opportunity to launch small satellites within small budgets. A significant outcome of such missions is the multi-disciplinary learning framework that prepares students for a future career in industry through hands-on, project-based education.

These missions are unique in that students have performed substantial and meaningful portion of tasks in design, integration and testing activities, and flight operations with students having direct control over the progress of the program.

From the initial beginnings in 1999 at Stanford University, USA the CubeSat program has become a global program integrating over 500 entities including 150+ universities, government organizations and private-sector enterprises. With the CubeSat program having been designed to realize space missions in a time span of two years or less, students have been able to hone their engineering competencies while delivering space missions with significant improvements in costs, schedules. performance and risk management.

Students by working in a multidisciplinary team environment have been able to sharpen their skills in problem solving, project management, effective team communication and development of entrepreneurial mindset; thereby helping them to become contributing engineers very early on in their careers.

With the student satellite activity catching on in many top-tier and second-tier universities, we can expect significant improvement in the quality of students entering the industrial workforce and increasing contributions to developing engineering solutions with focus on frugal engineering design solutions for complex systems.

Image Source: nanosats.eu

Thought Leader's Perspective

Evolution of Small Satellites - Technology Trends

M. Venkatarao
C.S. Prasad
R.K. Rajangam
Planet Aerospace
Bengaluru

Until about two decades ago, Space Science and Technology was an unexplored area for many in the world and was confined to a few nations and communities till the emergence of Small Satellite Technology. With the advent of 'miniaturisation' in electronics coupled with advanced software tools, industry started producing smart phones, tablets/computers, mass storage devices and autonomous automobiles etc. As an off-shoot of this development, highly reliable and mass produced commercial-of-the-shelf (COTS) electronic components / Micro-Electro-Mechanical-Systems (MEMS) devices became available at affordable cost. This, in turn, led to the idea of developing small satellites by students / academic institutions and later by industry as well.

Ever since its evolution in 1999, CubeSats have become very popular with universities to design, develop and launch small satellites. A CubeSat is a nano satellite of size 10 x 10 x 10 Cm3with a mass of 1.33 kg usually referred to as 1U. It is based on a modular design and can be stacked together into multiple units (2U, 3U ...) up to about 16U. The CubeSat proved to be a disruptive development in space technology since it enabled students, research scholars, space enthusiasts, institutions and industry to realise and launch about 1350 of them in a matter of two decades.

While many small satellites were initially developed and deployed for demonstration of some scientific / technology experiments with limited mission life, they are now increasingly finding a role in operational applications/services like

- Automatic Identification of Ships (AIS)
- Automatic Dependent Surveillance – Broadcast (ADS-B)
- Earth Observation and more Frequent Detection of Changes
- Mobile Communications / IOT
- Atmospheric / Environmental Observations
- Geodetic / Location Services
- Planetary Missions

Student / University Satellites:

In India, small satellite programme was launched by ISRO in 2002 with the main objective of encouraging student community to participate in the space related activities by wetting their hands in satellite design and development. More than ten nano satellites were launched by various universities and IITs and many more are expected in future. ISRO supported this programme by providing technical guidance to students as well as free launch service as a piggyback payload. Planet Aerospace, an association of scientists / engineers retired from

ISRO is training students from University / Engineering colleges by conducting workshops on nano satellites, thereby contributing to the capacity building in space technology.

Small Satellites by Industry:

Based on the success story of small satellites built by students and academic institutions for their scientific studies and ably supported by the availability of reliable COTS technology, market forces started a new gold rush in space. Industry soon realised the advantages of faster, better and cheaper attributes of small satellites and started deployment of large constellations for well-targeted applications such as Earth observation and communications in the civil, military, and commercial domains. Today, imaging of earth resources at high resolution (< 5 m) with a repeat coverage of few hours by deploying a fleet of 3U CubeSats and associated ground infrastructure is made possible by Planet Labs and others. Similarly, huge constellations of small satellites (< 400 kg) are being launched into low earth orbits (LEO) by SpaceX, OneWeb, Telesat and many others to provide high throughput and low latency direct-to-home (DTH) communication services (of course, at the cost of increasing space debris and obstructing astrophysical observations !!!). The small satellite business is expected to yield a revenue of over US $ 3200 million by 2028.

Technology Trends in Small Satellites

The driving force behind this explosive deployment of small satellites is twofold – user demands coupled with technology developments. To begin with, small satellites in general and nano / micro satellites in particular are severely constrained by their size, weight and power which in turn imposes limitations on the payload configuration for a given mission. Major constraints are in terms of

- Low Power Availability
- Reduced attitude pointing accuracy and platform stability
- Lower Data handling capability
- Use of Low Frequency (UHF/VHF) for Communication
- Lack of Propulsion System for Orbit Corrections
- Small Antennae
- Space Debris

Small satellites identified for operational services, particularly in constellations, have to be designed overcoming the above limitations to provide high-quality, long-life missions. This necessitated not only the development of new technologies but also ancillary industry to produce them in large numbers to meet the global demand. Some of these technologies are highlighted below.

a) Miniature Star Trackers: Star trackers provide much better accuracy for attitude measurements compared to Earth and Sun sensors. But their size, mass and power were quite high (> 2kg) for accommodation in small satellites. With the availability of small size optics of good image quality and two-dimensional active pixel sensor arrays with small pixel dimensions (< 5 μm) miniaturised star trackers (< 0.5 kg) have been developed and are commercially available.

b) Miniature Wheels: Nanosats and CubeSats use magnetic torquer coils as actuators for their attitude control with magnetometer error inputs. This type of system can provide attitude control accuracy of the order of 0.5 – 1.0 deg. To improve this accuracy to better than 0.5 deg, miniature reaction / momentum wheels of small torque (1-5mN-m) are now available commercially.

c) Micro-propulsion System: Many of the currently used nanosats and CubeSats are not equipped with propulsion systems for their orbit control because of weight and power constraints. However, this becomes a necessity when such small satellites are used in formations. A few micro-thrusters for propulsion are available at high cost. There is ample scope to develop low weight, low power chemical and electric micro-thrusters which can greatly benefit small satellites.

d) On-Board computer (OBC): Demands for on-board autonomy, intelligent telemetry and on-board data processing etc, have led to development of powerful processors with increased computing capabilities. Processors with built-in memory, various interface bus compatibility (USB, I2C), reliable software, low power consumption and small size are available in a wide choice (few examples – ARM Cortex M7, AMD-G series SOC, STM32). Going forward, artificial intelligence enabled OBCs with

(Picture credit:Leonardo Finmeccanica S.P.A.)

Mini Star Tracker

programmable software are expected to increase the power of OBCs.

e) High Speed Data Transmission: Applications like earth observation at higher resolutions, and low earth orbit communications demand high volume data rate transmission which in turn need to employ high frequency bands like S, X, Ku and Ka bands. Developments in Monolithic microwave integrated

(Picture credit: Cubesatshop.com)

Mini Reaction Wheel

circuit (MMIC) technology, phased array antennas and other RF components have enabled the use of these frequency bands. Implementation of very high data transmission rates using laser communication systems will enhance the

(Picture credit: Enpulsion Spacecraft Technology)

Micro-propulsion System

use of small satellites for communication. This requires high levels of precision so that the satellite's laser beam is perfectly aligned with the receiver located on Earth, while in low earth orbits at a speed of around 7.8 km/s.

f) Deployable Antennas: Foldable parabolic antennas make it possible to launch small satellites with stowed antennas which can be deployed in space. These greatly improve communications and bring capability of small satellites on par with larger satellites. While in- orbit deployable antennas of few meters in size with high profile accuracy have been developed for small satellites, there is plenty of scope for improvement including use of miniature phased array antennas.

g) Space Debris: One major disadvantage of small satellites is that they end up as large space debris at the end of their missions. Unless they are effectively deorbited, small satellites will create more harm than good in the long run. Therefore, worldwide attention is placed on developing various means of deorbiting satellites. Passive systems employing drag shields, sails, tethers as well as active systems employing thrusters, capture devices etc. are at an advanced stage of development.

Technology Evolution in Small Satellites

In the early phase, small satellites were mainly used as platforms for learning and technology demonstration. Payloads performed simple operations such as transmission of a beacon, storing data or transmitting data collected by simple sensors at very low data rate (1 to 9.6kbps) in VHF/UHF bands using wire antennae.

In recent times, the use of higher frequencies as S-Band (mainly for telemetry) and X-Band (for data transmission) has become widely available thanks to the advent of commercially available Monolithic Microwave Integrated Circuits (MMICs). The shift towards higher- frequency bands implies other requirements on the spacecraft design, such as the power system and the antennas.

The need of higher data rates, low cost, and small size has also moved the attention towards Free-

Space Optical (FSO) communications, especially for inter-satellite links. With the use of laser communication terminals in systems like the European Data Relay System (EDRS) for inter-satellite links, the technology has passed the barrier from research to the operational application. Even optical links from the Moon to Earth have been demonstrated. In the near future, optical communication systems for small satellites are likely to be commercially available.

Since the early days of small satellites, the trend has been to use low-cost COTS components in system hardware together with digital implementation. Thanks to the availability of modern high-speed, low-power digital signal processors and high-speed memories, the trade-off between the hardware/software implementation is moving more towards the software implementation and the concept of Software Defined Radio (SDR). For small satellites, which are designed with few years of lifetime in mind, the reason for moving towards SDR payloads is mainly related to the flexibility to adapt to new science opportunities and potentially reducing development cost and risk through reuse of common space platforms to meet specific mission requirements. SDR can be used to support multiple signals, increase data rates over reliable inter-satellite links to Earth, and also help in facing the shortage of available frequencies for communications in the more crowded bands.

Small satellites are also playing an increasingly important role in telecommunication architecture in two main ways:

(I) They are increasingly used to form application-focused segments of the infrastructure supporting existing communication architectures, notably the internet.

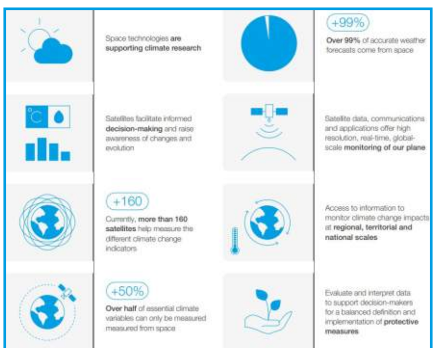
(ii) They also form and/or utilize altogether new, distinct communication architectures

The use of Earth-orbiting satellites to conduct internet traffic is not new. What is new is the use of large numbers of small satellites for this purpose. The field has grown rapidly in recent years as new concepts are proposed, many of them highly ambitious like the OneWeb constellation which is initially expected to comprise 882 small internet service delivery satellites in low earth orbit, potentially growing to 2620 satellites; Samsung's proposal of a 4600-satellite constellation, projected to be able to carry one billion terabytes of internet data per month; SpaceX corporation's Starlink constellation that is envisioned to comprise up to 12,000 small satellites in low earth orbit, with the capacity to carry up to 10% of local internet traffic in densely populated areas.

Along with technology evolution, there have been marked changes in the application of small satellites. Besides conventional applications such as earth observation, communications, space science etc., innovative business applications like advertising from space - projection of commercial messages in the night sky with the help of CubeSats, recovery of useful parts of de-orbited satellites are also being thought of.

Overall, small satellites are poised to greatly influence our lives in the coming years.

FIVE ways SpaceTech can help protect the planet



Benefits of Space Technologies for the SDGs
Image: UN

Satellites and other space technologies could be used to help mitigate the effects of climate change, as well as protect both animals and communities.

Satellite technology has long been used to predict the weather, with meteorological forecasts able to act as early warning systems for extreme weather events.

The technology is also key for documenting environmental changes and informing decision making by measuring sea levels, atmospheric gases and the planet's changing temperature, among other factors.

There are currently more than 160 satellites measuring different global warming indicators, with more than half of essential climate variables only measurable from space, according to the World Economic Forum.

But the technology could do more. Here are five ways space tech can help improve life on Earth.

1. Frontier technologies to tackle climate change
2. Satellites to track weather patterns
3. AI cameras to monitor wildlife crime
4. Sensors to track animals
5. Satellite images transformed into data for farmers

Source: weforum.org

India's First Government School in Karnataka to Launch Satellite

The Government Boys High School in Malleswaram, Bengaluru will be launching a student-built satellite in August 2022, and with this, will position itself as the first government high school in India to develop a satellite.

Karnataka's Minister of Science and Technology, Dr. C N AshwathNarayan while announcing this at Bengaluru on 8 July 2021 elaborated that designing and manufacturing the satellite would be done at the school by involving students from a few government schools. This project takes inspiration from the Prime Minister Shri Narendra Modi's concept of Gaganyaan Space Mission.

Indian Technology Congress Association (ITCA) would facilitate mentoring the student teams as part of the 75 Student's Satellites Consortium: Mission 2022 with the Indian Space Research Organization (ISRO) supporting the launch of the satellite.

Small Satellites Market Size

To Witness Double-Digit Growth in Next Five Years - A New Study from Stratview Research

Industry analyst, Stratview Research has announced the launch of a new research report on Small Satellites Market. Segmenting the market by Type (Minisatellite, Microsatellite, Nanosatellite, and Picosatellite), by Application Type (Earth Observation, Technology Development, Communications, and Scientific), by Operator Type (Commercial, Government, Civil, and Military), and by Region (North America, Europe, Asia-Pacific, and Rest of the World), and by Region (North America, Europe, Asia-Pacific, and Rest of the World), Stratview Research has comprehensively analysed today's small satellites market realities and assessed the future market possibilities for the forecast period of 2021 to 2026.

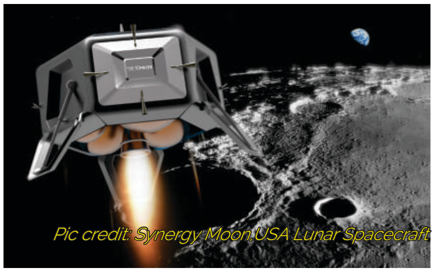
Defining the small satellites category as miniaturized satellites having a wet mass of under 500 KG are characterized by shorter development team and cycles; and can be developed and launched at a lower cost in comparison to traditional large satellites. Development in computational technology and data analytics have driven the miniaturization of satellite systems, and the number of small satellites launched in the past few years has surged substantially owing to its low cost, easier launch vehicle integration, and technological innovations.

The report notes that SpaceX's robust plan of launching about 12,000 satellites in the Starlink constellation, of which half of them are targeted to be launched by end of 2024, is signalling a highly optimistic near-term outlook for the industry, especially of small satellite ones.

Source: stratviewresearch.com

New Space Exploration and Opportunities

Dr. Jayakumar Venkatesan
CEO, Valles Marineris International and Visionary, Upgreat Technology Contests (RVC, Skolkova Foundation, ASI) Russia



Pic credit: Synergy Moon USA Lunar Spacecraft

Journey of Valles Marineris International in the New Space Era

With the launch of Sputnik in 1957 and the subsequent beginning of the space age, the progression of Space Technologies has, on the one hand, led to the development of hundreds of applications that use satellite data, including devices for everyday use, from satellite televisions to the Satnav in our cars. On the other, it has underpinned scientific progress in Earth and Atmospheric Sciences as well as in Astronomy and Astrophysics. Just to recall some of the highest public profile contributions from the field, satellite measurements showed the extent of the ozone layer depletion in the atmosphere and the existence of exoplanets and black holes have been confirmed, among many other scientific advances. The rapid progress made in Space Technology led to extraordinary accomplishments for the whole human race, such as the Moon landing.

Valles Marineris International was took part in $30 Million Google Lunar Xprize Challenge as partner with Synergy Moon to explore the Moon. The Google Lunar XPRIZE (GLXP), sometimes referred to as Moon 2.0, was a 2007–2018 inducement prize space competition organized by the X Prize Foundation, and sponsored by Google. The challenge called for privately funded teams to be the first to land a lunar rover on the Moon, travel 500 meters, and transmit back to Earth high-definition video and images

Jayakumar Venkatesan took the responsibility as Chief Technology Officer to design and develop the spacecraft systems according to the competition guidelines. The Competition guidelines required the rover to travel 500 metres and transmit images, video, data, an sms and an email back to Earth. With working groups on in over 15 countries and on 6 continents, Team Synergy Moon promotes international cooperation in space exploration and development.

Teams had until 31 March 2018 to launch their missions. On 23 January 2018, the X Prize Foundation announced that "no team would be able to make a launch attempt to reach the Moon by the [31 March 2018] deadline... and the US$30 million Google Lunar XPrize will go unclaimed. Synergy Moon reported in February 2018 that they are negotiating with Team Indus to possibly launch their Landers together, aiming for a launch in 2019.

Valles Marineris International still continues moon landing programme along with former Google Lunar Xprize Participants to fulfill the dreams of everyone.

Human Spaceflight Programme

In General Human spaceflight (also referred to as manned spaceflight or crewed spaceflight) is spaceflight with a crew or passengers aboard a spacecraft, the spacecraft being operated directly by the onboard human crew. Spacecraft can also be remotely operated from ground stations on Earth, or autonomously, without any direct human involvement. People trained for spaceflight are called astronauts, cosmonauts, or taikonauts; and non-professionals are referred to as spaceflight participants. The first human in space was Soviet cosmonaut Yuri Gagarin, who launched on 12 April 1961 as part of the Soviet Union's Vostok program. Humans traveled to the Moon nine times between 1968 and 1972 as part of the United States' Apollo program, and have had a continuous presence in space for 20 years and 307 days on the International Space Station (ISS)As of 2021, humans have not traveled beyond low Earth Orbit since the Apollo 17 lunar mission in December 1972.

Currently, the United States, Russia, and China are the only countries with public or commercial human spaceflight-capable programs. Non-governmental spaceflight companies have been working to develop human space programs of their own, e.g. for space tourism or commercial in-space research. The first private human spaceflight launch was a suborbital flight on SpaceShipOne on June 21, 2004. The first commercial orbital crew launch was by SpaceX in May 2020, transporting, under United States government contract, NASA astronauts to the ISS.

Recently ISRO human Spaceflight programme Gaganyaan was announced. The Gaganyaan is an Indian crewed orbital spacecraft intended to be the formative spacecraft of the Indian Human

Soyuz Spacecraft Training Simulators for Space Enthusiasts

Spaceflight Programme. The spacecraft is being designed to carry three people, and a planned upgraded version will be equipped with rendezvous and docking capability.

Valles Marineris International made partnership with Russian Partner , Who is building the soyuz manned spacecraft training simulators for professional cosmonaut training. Valles Marineris International ready to offer the crew training for professional cosmonauts and amateur learning experience of manned spacecraft training simulators. We also have Soyuz Spacecraft Simulators for children's age 8 years above. This can provide learning experience for the children's. It will be to learning edutainment platform.

We are also offering AR/VR spacewalk experience, so that learners can feel the spacewalk and visualize the space environment.

Microgravity Research in ISS and Three-dimensional Bioprinting in Space

Valles Marineris International made co-operation to organize the international space station experiments. Valles Marineris International encouraging the space industry professional to conduct the science experiments in ISS.

Nanotechnology development allows for the management of living cells, tissue spheroids and synthetic microscaffolds by using magnetic fields. This, in turn, leads to attempts to create magnetic bioprinters.

However, the first attempts to create magnetic bioprinters showed that terrestrial gravitation represents a significant limitation. It is reasonable to assume that in a gravity-free environment, magnetic and diamagnetic levitation will allow not only so-called "formative" biofabrication of three-dimensional (3-D) tissue constructions, but even programmable self-assembly of 3-D tissue constructions in a controlled magnetic field. The space magnetic 3-D bioprinter, which can manage tissue spheroids in microgravity, is a practical implementation of the new perspective concept of formative biofabrication. Microgravity biofabrication on the basis of magnetic forces transforms the technology of 3-D bioprinting and opens real opportunities for programmable self-assembly of tissue and organ constructions of tissue spheroids in 3-D space without solid scaffolds. Formative fabrication and programmable self-assembly are revolutionary manufacturing and biofabrication technologies of the 21st century. Today, there are three main 3-D bioprinting technologies: extrusion, inkjet and laser-based bioprinting. These methods have common limitations such as slow speed and the inability to create 3-D constructs with complex geometry. Therefore, new approaches such as acoustic or magnetic bioprinting using patterned physical fields for predictable cells spreading will evolve.

The main idea is to use microgravity as a co-factor of bioprinting technology. This concept means using a scaffold-free, nozzle-free and label-free (i.e., without using magnetic nanoparticles) approach called formative biofabrication, which has the edge over classical bottom-up additive manufacturing. This technology could be commonly used for space radiation studies to provide long-term crewed space flights, including the moon and Mars programs.

3D Magnetic Biorpinter experimented by Russian Cosmonaut Oleg Kononenko

3D Bioprinting Solutions developed a novel space 3-D bioprinter (see image below), which will enable rapid, label-free 3-D biofabrication of 3-D tissue and organ constructs in the condition of microgravity by using magnetic fields. Meanwhile, a sophisticated holistic cuvette system for delivering living objects to the ISS, performing biofabrication, and transferring bioprinted constructs back to Earth has been developed.

Rapid biofabrication of 3-D organ constructs of thyroid gland and cartilage using tissue spheroids (i.e., thyreospheres and chondrospheres) in the conditions of natural space microgravity will be launched during space experiments. After the return of bioprinted constructs to Earth, histological tests will be conducted to examine the internal structure.

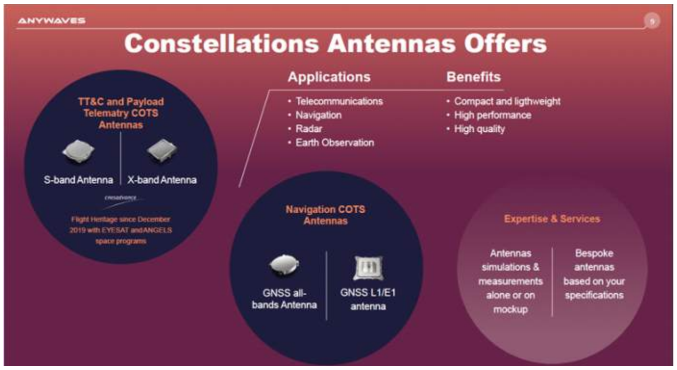
The 3-D bioprinter will become a part of ISS scientific equipment for conducting further international experiments by any scientific groups and companies interested in 3-D bioprinting technology. That means we are developing a novel shared research infrastructure for unique biomedical research on the ISS.

Analog Astronaut Training

Valles Marineris International made partnership withAnalog Astronaut Training Center,Poland. It is a private company, which accelerates human spaceflight scientific studies. AATC was created by former European Space Agency professionals: engineer and scientist. In 2018, the company

3D Bio Printer

established a laboratory to simulate space environment for scientific experiments focused on space biology and medicine. The facility is located in Rzepiennik, South of Poland. It specialises in operational trainings for scientists, engineers, space enthusiasts and future astronaut candidates. Beside scientific projects, co-supervision of engineer-master and doctoral theses, AATC organizes rocket workshops, stratospheric missions and scientific lunar and martian analog simulations. In 2021 the company has reached 32 successfully organized analog simulations, what positions Poland on the top in Europe considering the number of organized expeditions. Most of trained analog astronauts continue their career in the space sector.



Valles Marineris International offer training activities in the field of the studies like Aerodynamic Tunnel, Skydiving, TCCC, HUET Szczecin, HUET Gdynia, Hyperbaric Chamber, WIML Centrifuge, Stratospheric Balloon Aerobatic, Powered Planes, Glider Planes, Rescue Diver, Moon Rocks at Speyer, Buran at Speyer, Flight Simulator, Medical Training, Stratospheric Science,Space Facilities and Training Centers, and Advanced Medical Trainings. Also offering analog astronaut training programme year around the batches.

Satellite Antenna for All your Mission Needs

Valles Marineris International, the authorized the distributor of all types of satellite antennas for your space missions. A new generation of miniature and high-performance antennas designed according to space standards as an answer to the satellites constellations market's needs.

More Details:
www.vallesmarineris.in
jayakumar@vallesmarineris.in

Indian National Space Promotion Authorization Centre (IN-SPACe)

The Indian government established a new entity called the Indian National Space Promotion and Authorization Centre (IN-SPACe). IN-SPACe is a Single-window Nodal Agency created to accelerate the commercialisation of Indian space operations. As a companion to the ISRO, the agency's mission is to encourage Non-Governmental Private Entities (NGPEs) to enter the Indian space industry. In addition, the agency would encourage a speedier introduction of private participants in the sector by encouraging policies in a favourable regulatory environment and sharing existing required infrastructure.IN-SPACe is an autonomous nodal agency within the Department of Space (DoS) responsible for authorising NGPEs to conduct space operations, use DOS-owned facilities, and prioritises the launch manifest.

An ISRO-industry interface system would be created to provide easy contact with companies and assist them in developing new technologies. In addition, ISRO will use this method to share its knowledge on quality and reliability processes, documentation, testing techniques, etc.

The Indian government makes choices on authorising and regulating private-sector space operations and creating a fair playing field for both start-ups and commercial corporations. The range of activities would include the construction of standard satellites, rockets, and commercial launch services.

ISRO will also identify areas in which companies would face problems in new technological sectors. The government will promote the shortlisted ideas for partial funding through established channels. This method will also be used to announce possibilities for selected research and exploration missions to commercial businesses.

Source: Isro.gov.in

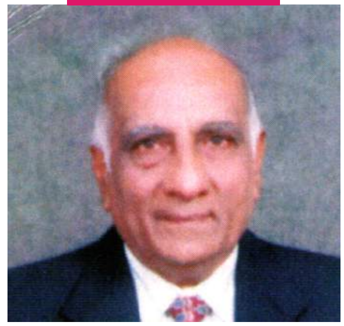
Dr Pawan Kumar Goenka is the first IN-SPACe's Chairperson

Dr Pawan Kumar Goenka, Former Managing Director Mahindra and Mahindra Ltd, is one of India's leading Industrialist.

Dr Goenka's groundbreaking work in engine tribology has garnered him international recognition. His 20-year-old methods for analysing engine bearing and friction are still utilised as a standard reference in car engineering. He is also an expert in car pollution reduction and alternative fuels.

End-User Thoughts

SmallSats for Social Good



D V Naghabhushan
Former Chairman
Agriculture Division Board
The Institution of Engineers (India)

A Forward-thinking Perspective

Space-based services have become a fundamental part of the citizens' daily routine. The estimated 3000 active satellites in space generate massive data that support the global economy, national security, transportation and infrastructure systems and promote effective decision-making. It is only expected to become more pervasive as more countries and more organizations launch and operate satellites. In addition, industry analysts predict that more than 50,000 small satellites would be launched globally by 2030, deepening humanity's use of space and space-based assets.

Space technologies have been a key influencer in driving innovations in agriculture, heralding an era of precision agriculture. For example, remote-sensing satellites have provided vital data for monitoring the health of the soil and crops, tracking drought conditions, estimating fertilizer needs, planning the timing and irrigation required for crops, and overseeing crop development and yields. In addition, the proliferation of access to geospatial data, availability of analysis-ready agricultural thematic geospatial data products, and the lower cost of geospatial information technology facilities have stimulated the ubiquitous deployment of space-enabled farming products and services across the country.

Technology exists for farmers to use soil-sampling machinery outfitted with GPS receivers to assess soil and gain actionable insights into crop diseases, insect infestations, bare soil, phosphorus and nitrogen content, and quickly take steps as the situation warrants. Such variable rate technology, as this practice is called, avoids the over-application of pesticides and nutrients.

Satellite data plays a vital role in supporting government actions by integrating interventions by governments and their departments, universities, and non-governmental organizations to develop cohesive and holistic public policy to address food security.

Weather satellites can minimize hazards for fishermen, while GPS functionality enhances accuracy and precision for navigation and maximizing fishing yields by observing oceanographic data influencing fish movements such as sea surface temperature, ocean colour, and other parameters.

Satellite services are increasingly being used to monitor the weather and predict changes to the Earth's climate and atmosphere. Accurate and timely weather forecasts are significant data assets for governments to proactively anticipate and prepare for disasters; while successfully protecting citizens' lives, property and infrastructure. In addition, enterprises can effectively use weather data to protect supply chains, plan production and mitigate risks.

Space-based services have become highly vital for saving citizens and protecting property in times of disasters. Furthermore, in the unfortunate event of terrestrial communication services getting disrupted, space-based services provide an alternative method to maintain the connection with the impacted citizens and ensure focused relief measures are taken by the government without losing time. Furthermore, satellites have repeatedly been shown to ensure that rescue teams have current and up-to-date information on effective methods to rapidly reach the disaster-hit region and offer reliable data on the state of infrastructure elements within hours or minutes of an occurrence.

Space applications play a critical role in education dissemination. Online and E-education initiatives can benefit from satellite telecommunications. Public-private partnerships must be developed so that online education's last-mile reach in rural areas is given the priority it deserves. The governments, the institutions including agricultural, The space industry along with the Indian Space Research Organization, and the New Space entities like the ITCA, TIMISAT, TSC Technologies and other start-ups are working to progress the development of constellations of commercial satellites to address societal applications which are highly critical to holistic national development and progress.

Bharti Group-backed OneWeb Launches 34 Satellites

OneWeb, the Low Earth Orbit (LEO) satellite communications company backed by Bharti, has announced the launch of 34 satellites by Arianespace from the Baikonur Cosmodrome in southern Kazakhstan.

The latest launch brings the company's total in-orbit constellation to 288 satellites. OneWeb said it is on track to commence service this year and deliver global service in 2022.

The move highlights the business momentum as the company prepares to introduce commercial service and focus on scaling to global service.

The satellites would form part of OneWeb's 648 LEO satellite fleet that aim to deliver high-speed, low-latency global connectivity. OneWeb is fully-funded to deliver its constellation and take its satellites into commercial service.

"OneWeb remains on track to deliver global service in 2022 and is seeing growing demand from telecommunications providers, ISPs, and governments worldwide to offer its low-latency, high-speed connectivity services to the hardest to reach places," .

Since early 2021, OneWeb has announced distribution

partnerships across various industries and businesses, most recently with Northwestel in Canada and BT in the UK.

Source: yourstory.com

Future Launch Landscape

Upcoming Wave of Demand and Customer Requirements Push Changes

A new type of space logistics is coming with the expansion of space exploration, said Tory Bruno, CEO of United Launch Alliance (ULA). “When they put twice as many people in the [International] Space Station and around the Moon, and then on the surface of the Moon, there will be a logistics train constantly going back and forth with consumables,” Bruno said. “That will be very interesting.”

These new ideas are attracting more and more investors. There has been massive growth in investments, said Josh Brost, vice president of Business Development for Relativity Space, including billions of dollars for constellations. “On the launch side, an investor community is looking for something more capable. And there are more rockets today than at any time in history.”

The growth that the satellite industry is experiencing is not about bigger satellites, but a greater volume of satellites, said Jim Simpson, chief strategy officer for Virgin Orbit. “The capabilities we’re seeing now we weren’t even seeing two years ago,” he said. “Now we are seeing satellites the size of a grilled cheese sandwich.”

Tiphaine Louradour, president of International Launch Services, said customers have a greater variety of mission requirements now than in the past.

“There is a combination of mainstream providers and then new entrants driving funding that space launch companies have seen,” Louradour said. “We are seeing an increase in the variety of mission requirements and mission orbits, which means requiring flexibility and reliability in launch services as keys to good customer service.”

Source: interactive.satellitetoday.com

A Standardized Picosatellite Experience

G. Morelli
H.C. Karakus
S. Mukherjee
R. Casesa
G. Parissenti
GP Advanced Projects srl, Italy

FEES from preliminary design to in-orbit operations

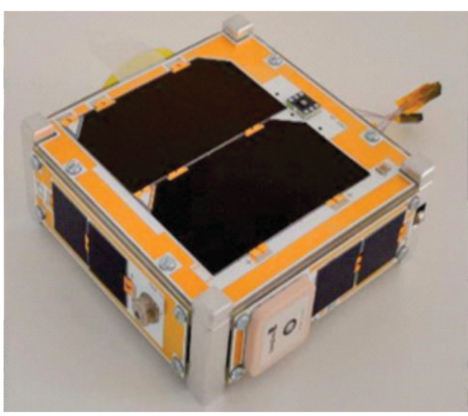
Over the past couple of decades, the exponential growth of building satellites leads us towards the interesting innovation of space technology: as the aerospace industry is facing a quick expansion, Cubesats and related "small" projects are getting more frequent. Generally, programs that regard space missions can be referred to as "long-term", though Cubesats missions are relatively facilitated in terms of necessities: standardization plays an important role in this respect, yet flight heritage and experience are indeed precious elements when it comes to improving results and saving resources.

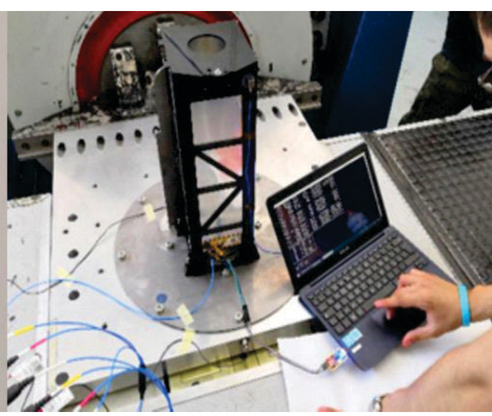
GP Advanced Projects is an innovative SME active in both production and management of space projects. The company has qualified its proprietary pico-satellite platform able to perform IoD/IoV activities in LEO, which allowed further growth toward technology readiness and development. In addition, thanks to its experience in project & innovation management, GP Advanced Projects enabled different non-space companies and institutions entering the space sector; the company is also actively engaged in scientific projects for both ESA and NASA. All of this, has been made possible by a passionate team of young engineers and managers, based in Brescia, at the crossroad between Milan and Venice.

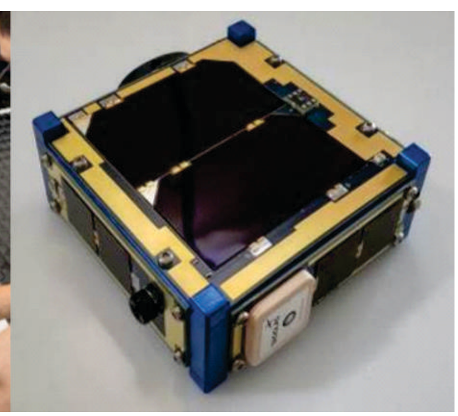
Flexible Experimental Embedded Satellite (FEES) is the first satellite launched by GP Advanced Projects and an active mission in low earth orbit (LEO) (sun-synchronous ~550 km, 97.4°), consisting of a 1/3U pico-platform compliant with the Cubesat standard, which includes all the main systems and subsystems necessary for a spacecraft of this kind: its main objective is the validation of an experimental model for in-orbit testing of components for space. By accomplishing the mission, it aims to act as a low-cost platform for further payload validation testing.

More specifically, the FEES' mission concept was born in 2016 and developed ever since: its objectives include the in-orbit qualification of an ADCS architecture (e.g. PCB embedded magnetorquers), an EPS which includes a commercial battery powered by innovative solar panels, some of which are experimental and now space-validated, and a fully equipped TT&C system able to operate at several transmission protocols and frequency bands (430-440 MHz, 1260-1270 MHz) by using FSK and LoRa modulations. Further goals include IRIDIUM inter-satellite communication, Earth imaging and measurement of the mission dose thanks to an innovative radiation experiment called RadEx2.

The satellite has been developed with a qualification-acceptance model philosophy, which involves the implementation of a Qualification Model to perform all the possible tests and consolidate the design, and a Flight Model, which has only gone through the required validation process before flight.





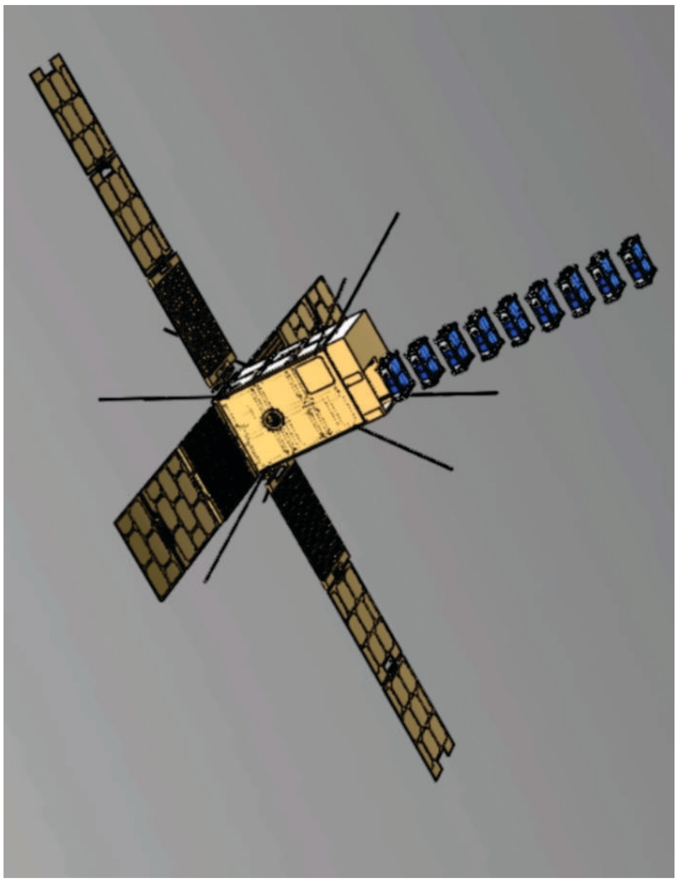


Baikonur onboard a Soyuz-2 launch vehicle operated by GKLS, as piggyback of UNISAT-7 satellite property of G.A.U.S.S. srl, which released it in a LEO Sun-Synchronous Orbit (SSO) at 550 km on 25th March, 22:10 UTC. Its very first beacon signal has been received at 23:45 UTC the same night.

Implementing commercial off-the-shelf (COTS) components in a Cubesat design is often a valuable choice: special attention should be paid to batteries, which introduce can easily cause damage from testing and be considered hazardous. On the contrary, components' bakeout rarely results in outgassing. It is crucial to establish integration procedures for sensible components and even more is to test systems and subsystems functionalities as soon and carefully as possible to correct eventual mistakes. Licensing and paperwork usually take much to come into effect and are compulsory, especially for radio frequency allocation.

Moreover, it is vital to have a functioning ground station by the time a Cubesat is put into orbit: failure to secure link communication with a spacecraft upon detachment might jeopardize the entire mission. Testing ground might consist of radioamateur satellites which are in orbit and easily available, of which FEES is an example.

FEES is free to be observed at 437.2 MHz, and the beacon is transmitted alternatively through LoRa (Modulation band width: 125 KHz, Spreading factor (data rate): 9, Error correction code rate: 1, Preamble length: 5, Symbol timeout: 5, Symbol hop: 4) and FSK signals (Frequency deviation: 2500, Data rate: 9600, Modulation band width: 50000, Expected preamble length: 3) parted by 1 minute; it is also supported by the TinyGS open network (https://tinygs.com/satellite/FEES), where its messages are reported publicly. Typically, the battery status is around 3.7 V and the messages are received with -120 RSSI and -15 SNR, considering a 0.5W radio output power. Its NORAD ID number is 48082 (International designator 2021-022AL).



Our ground station is located at our operative headquarters and includes commercial and in-house-developed systems: it consists of two main antennas (UHF and VHF) connected to radio amplifiers for telecommunication link with the orbiting satellites, and additional antennas for monitoring the health of the sent and received messages. Due to specific power requirements dictated by LoRa utilization and especially related to signal amplification, some modules had to be developed in-house rather than procured. The main antennas follow the satellites' orbits by means of a rotor controlled automatically or manually through a computer according to the spacecraft trajectories. It is currently operative for the FEES mission and expected to be exploited for PiCo.

PiCo is the flagship project of GP Advanced Project, with the goal of realizing the first private nanosatellite constellation, to offer an IoT data retrieval service available all over the world. It stems from the miniaturization capabilities of FEES and consists of a constellation of 1/3U Cubesats which is able to retrieve data in VHF band, providing key information especially in the agriculture, oil & gas and wildlife industries. The small size makes PiCo satellites suitable to build a competitive constellation of about 100 satellites, but can also be launched in a lower number (minimum 9) for customers requiring their own nanosatellite quick deploy-low cost constellation, arranged in dedicated missions. PiCo aims to reach any potential user with affordable and simple terminals, helping to generate positive impacts towards the UN sustainable development goals. To do so, a second demonstrator called FEES2 has been developed very similarly to its predecessor, with an additional integrated VHF radio module, ready to be launched from the ISS in Q1 2022.

For further information
www.gpadvancedprojects.com
info@gpadvancedprojects.com

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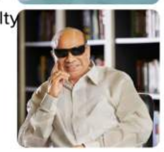

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Dr.N.Marie Wilson, Managing Director, Jeppiaar Institute of Technology, supports and enables a team of young minds to soar their way into Space on board ISRO's PSLV C-51, on February 28th, 2021

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Space-related Educational Resources

NASA helps Students Launch Satellites in New School Year

As students head back to school, NASA is ready with resources for students, teachers and families.

From kindergarteners to college students and beyond, NASA has resources and opportunities available that are designed to inform and excite students, and to involve them in the space agency's many upcoming initiatives.

"We hope to enlist students in joining us on NASA's exciting journey," Kris Brown, Deputy Associate Administrator for NASA's Office of STEM Engagement, told Space.com. (STEM stands for "science, technology, engineering and math.") "We've got, in particular, a number of really exciting mission milestones coming up over the fall."

(Image credit: NASA/JPL-Caltech/MSSS/Seán Doran)

NASA offers teachers, schoolkids and their families educational resources about many agency missions, including that of its Perseverance Mars rover. This mosaic, which shows Perseverance and NASA's Ingenuity Mars helicopter, was created by citizen scientist Seán Doran using 62 images captured by Perseverance on April 6, 2021.

Source: space.com

Nano and Microsatellite Markets-2026

Opportunity in the Growth in the Demand for Satellite Imagery from Non-Governmental Players

The global nanosatellite and microsatellite market size is expected to grow from USD 2.3 billion in 2021 to USD 5.7 billion by 2026, at a Compound Annual Growth Rate (CAGR) of 20.4%. Commercial companies, researchers, academia, and the government are building CubeSats for various operational missions. Commercial companies use these miniature satellites for global imaging and communications while researchers and academia continue to use them for R&D. These CubeSats provide an affordable means of demonstrating exciting new technologies, along with driving the drastic miniaturization of systems and encouraging a new approach to spacecraft integration.

ResearchAndMarkets.com

Source: businesswire.com

Space Law Treaties and Principles

The Committee on the Peaceful Uses of Outer Space (UN-COPUOS) is the forum for the development of international space law. The Committee has concluded five international treaties and five sets of principles on space-related activities.

These five treaties deal with issues such as the non-appropriation of outer space by any one country, arms control, the freedom of exploration, liability for damage caused by space objects, the safety and rescue of spacecraft and astronauts, the prevention of harmful interference with space activities and the environment, the notification and registration of space activities, scientific investigation and the exploitation of natural resources in outer space and the settlement of disputes.

Treaties

The treaties commonly referred to as the "five United Nations treaties on outer space" are:

The "Outer Space Treaty"
The "Rescue Agreement"
The "Liability Convention"
The "Registration Convention"
The "Moon Agreement"

The five declarations and legal principles are:

The "Declaration of Legal Principles"

The "Broadcasting Principles"

The "Remote Sensing Principles"

The "Nuclear Power Sources" Principles

The "Benefits Declaration"

https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html

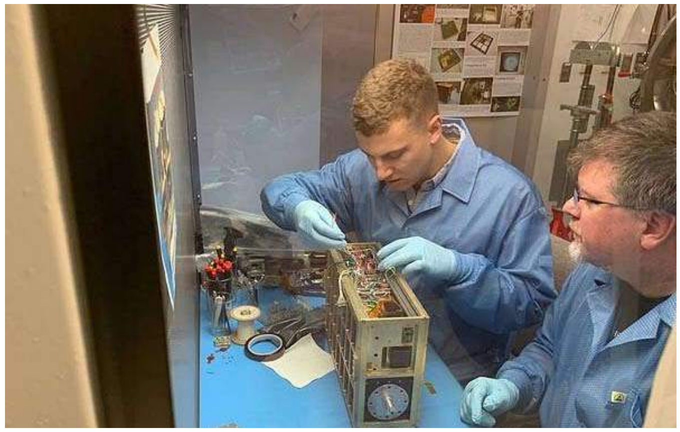
Cusp Plasma Imaging Detector (CuPID)

CubeSat will get new perspective on Sun-Earth boundary

When you help build a satellite the size of a shoebox, you learn pretty much everything about it, says Emil Atz, a PhD candidate in Mechanical Engineering at Boston University. You learn how to write a proposal to fund it, how to place the screws that hold it together, how to test each instrument to ensure it functions properly.

This September, a rocket will launch from Vandenberg Space Force Base in California, bringing with it Landsat 9, a joint mission of NASA and the U.S. Geological Survey. The rocket will also carry four CubeSats - compact, box-shaped satellites used for space research projects.

Source: spacedaily.com



Artificial Intelligence in Space

Preparing for the Future

When we think of robots, we tend to personify these non-human aids and give them human-like features. But even though a lot of research has gone into developing these humanoid machines, we are still a long way from a world where they could take over, or even mimic the actions of a person.

Robots are machines that have inbuilt artificial intelligence. They are used in all kinds of situations, especially where they can alleviate strenuous tasks or complete missions that are too dangerous for a human to undertake.

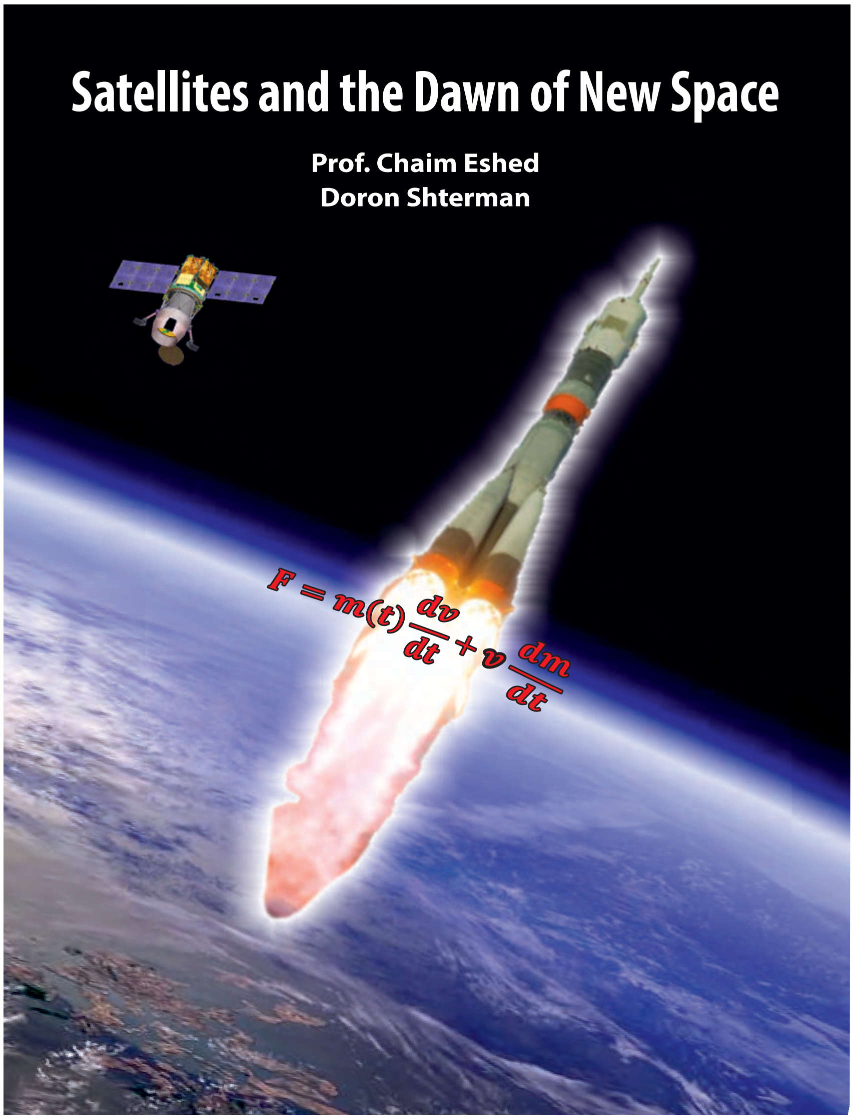
The term 'artificial intelligence (AI)' comprises all techniques that enable computers to mimic intelligence, for example, computers that analyse data or the systems embedded in an autonomous vehicle. Usually, artificially intelligent systems are taught by humans — a process that involves writing an awful lot of complex computer code.


ESA-wide applications of AI/ML

But artificial intelligence can also be achieved through machine learning (ML), which teaches machines to learn for themselves. ML is a way of 'training' a relatively simple algorithm to become more complex. Huge amounts of data are fed into the algorithm, which adjusts and improves itself over time. In ML, machines process information in a similar way to humans by developing artificial neural networks. This type of artificial intelligence has taken major leaps forward since the dawn of the internet.

Deep learning (DL) is a specialised technique within ML, whereby the machine utilises multi-layered artificial neural networks to train itself on complex tasks like image recognition. This can happen via supervised learning (e.g. feed the system Moon and Earth pictures until it can successfully identify both types) or unsupervised learning, where the network finds structure by itself. Good examples of deep learning are online translation services, image libraries and navigation systems for self-driving cars or spacecraft.

Source: esa.int

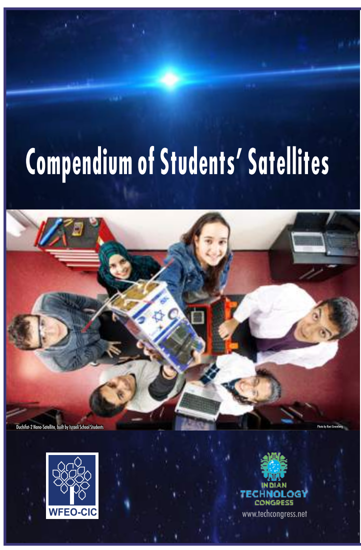


ITCA and University Space Engineering Consortium (UNISEC)-India have signed MoU during the Indo-Israel Space Leadership Programmes Organised during 2018-19 for Publishing the Original Book of **"Satellites and the Dawn of New Space"** written originally in Hebrew for Israel's Tel Aviv University, Technion Institute of Technology and Herzliya Science Centre/Schools of Israel!

The book was unique and instrumental for the successful design and development, fabrication, integration and launch of "Nano Satellites" by Israel School Students and University Students!

The book begins by describing the unique environmental conditions prevalent in the area of space near Earth and continues with a description of the moving bodies in space and the capabilities needed by a satellite launcher to insert a satellite into orbit around the Earth. Later on, the book provides a comprehensive description of the systems vital to the function of the satellite under the environmental conditions in space. The last part of the book provides examples of space missions and an extensive survey of Israel's assets in space, since the establishment of the Israeli space program and until today.

For more details contact:
secretarygeneral@itca.org.in



Advances in engineering and technology have powered societal development, and society has benefitted from the exploration and exploitation of space for myriad applications including weather forecasting, response to natural or man-made disasters, communication and navigation; and security. Development of space technologies has successfully contributed to man's conquest over distance and terrain to ensure equitable and sustainable social development.

In this context that the World Federation of Engineering Organizations Standing Committee on Information and Communication (WFEO-CIC) has collaborated with the Indian Technology Congress Association (ITCA) developed a publication titled **"Compendium of Students' Satellites"** that chronicles the various student-satellite programs being undertaken globally and will help structure a program relevant for Indian needs. It would build synergy between academia, industry and international agencies to highlight the benefits of small satellites for societal advancement and inspire the engineering youth in India and help enhance their learning and readiness to join the industry.

For Hardcopy of this book please contact: president@itca.org.in

End-User Thoughts

Impact of Space Technologies on Sustainable Development Goals

Dr. Wooday P. Krishna
National President,
Indian Institution of Production Engineers,
National Council Member,
The Institution of Engineers (India)

The United Nations (UN), involving more than 190 Member States, has developed the 2030 Agenda for Sustainable Development in order to address these challenges in the form of 17 Sustainable Development Goals (SDGs) with 169 associated specific targets

Satellites and space exploration have enormous potential to help accomplish the set targets of SDGs. Space science, engineering, and technology are used in information technology, contemporary communications, global positioning systems, digital broadcasting, weather prediction, and remote sensing. They give real-time information and time-series data from any central or remote location to aid policy choices. They are essential for tracking progress on key Goals Indicators.

The advancement of modern space systems has the potential to have a force multiplier effect on a variety of social circumstances. Technologies developed for space missions can be taken and adapted for terrestrial use. National investments in space research can assist in communicating scientific knowledge to a larger population while also opening up new opportunities for innovation and infrastructure development.

Image Source: unoosa.org

Global synergy and collaboration in space exploration have enabled numerous possibilities to push the boundaries of knowledge in several domains, spawning new fields of study and using the new skills to build navel products that meet societal needs.

Realizing the ambitious development goals necessitates the careful integration of space capabilities created by nations with in-depth specific talent; multi-stakeholder entities are ideally positioned to forge global and multilateral public-private partnerships to harness space for the SDGs.

The Indian Technology Congress Association, a professional association of interdisciplinary engineers, has been assisting in developing the capability to fulfil social demands. ITCA adherents from India's top space research organization and academia have created multidisciplinary teams to address specific pain areas and deploy technology solutions.

These teams have gone on to do research in academic institutions, mentor students with an entrepreneurial mindset, and now incubate start-ups engaging in the New Space era. ITCA has also created actionable synergies with R&D, academia, and industry in countries including Israel, UK, USA, Serbia, etc.

ITCA-incubated start-ups and partners are creating New Space CubeSats to deliver SDG 2030-focused space applications in agriculture, water conservation, clean-smart cities, and municipal dumping.

Space Technologies for Sustainable Development Goals 2030: Scorecard

Transformational

- Crop Productivity Optimization
- Food security and safe distribution
- End Malnutrition's

- Urban Planning and Infrastructure Monitoring
- Expansion and Improvement of City Services
- Deployment of sensor based smart waste management systems

- Climate early warning systems and mitigation plans
- Reduce Global Co2 levels
- Human and Institutional Capacity Building

- Increase afforestation and reforestation
- Biodiversity protection and Predicting conservation hotspots
- Identifying human-animal conflict zones

- Geo-Referenced Baseline Inventory of Skill Facilities
- Tele-Education to Overcome Geographic Limitations
- Literacy Enrichment

- Monitoring and Prevention and planning of infectious diseases and epidemiology
- Regulating Air pollutants
- Telemedicine and Telesurgeries

ITCA Studies on Influence of Space Technologies on Sustainable Development Goals (2020)

Positive

- Natural resource optimization
- Disaster Mitigations
- Providing targeted support to vulnerable societies

- Geospatial data for precipitation forecasts, evapotranspiration data
- Increase Water Use efficiency
- Efficient Sanitation management

- Power Grid Synchronization
- Enhancing clean Energy options including Solar and Wind
- Global Energy mix decisions forecasts

- Establish safe and secure working environments
- Lone Workers Monitoring
- Improve higher level of economy

- Geospatial technologies for Infrastructure Mapping and Monitoring
- Smart Mobility
- Increases Resources use efficiency

- Natural Resources Management-reducing resources use, and minimizing degradation
- Integrating supply chain, from producer to final consumer
- Sustainable tourism

- To enhanced productivity in fishing operations
- Ocean Biodiversity protection
- Marine Mining exploitation

Moderate

- Combat gender inequality by eliminating violence and human trafficking
- Use communication technologies for empowerment of Women
- Spread of social protection polices to all deprived

- Satellite technologies enable safe and responsible migration and mobility of people
- Monitoring global financial markets
- Equal prospects for countries and people

- Satellite technologies enable deployment of electronic tracking devices; to ensure the safety of children using dedicated wearables; and to prevent theft by monitoring assets
- Reduce corruption
- Improves the decision making arrangements

- Advances International Cooperation
- Promoting compatibility and interoperability of all systems
- Improves trade relations

Technologies Used

Satellite Earth Observation

Satellite Communication

Satellite Positioning

Technology Transfer

Inspiration drawn from Research and Education and

Microgravity Research

Global Practitioner

Our living style in pursuit of a sustainable world

Brig Gen (res) Prof Chaim Eshed
Co-Founder, Israel Space Agency
Retd Brigadier General,Israel's Military Intelligence Directorate

Speaking at the inauguration on "Our living style in pursuit of a sustainable world", Prof. Chaim Eshed, Co-Founder, Israel Space Agency, and former Brigadier General, Israel Military Intelligence Directorate touched upon the immense wisdom documented in ancient scriptures including the Vedas, Bhagavadgita and the Bible; and the thoughts expressed by Mahatma Gandhi, Albert Einstein and Prof. Robert Oppenheimer. He also pointed out the progress achieved by the two nations-India and Israel through technological innovation driven by the needs for national and homeland security.

Pointing out the relevance of space technologies for achieving the Sustainable Development Goals, Prof. Eshed articulated how remote-sensing satellites could provide actionable data for monitoring the soil, snow cover, drought, crop development, and proactively addressing global crop fluctuations and disruptions in food supply.

Recalling the common approach by both Israel and India in promoting engagement by academia, industry and government, Prof. Eshed emphasized the relevance and importance of some of the initiatives nurtured by the Indian Technology Congress Association (ITCA) including incubating start-ups, establishing multidisciplinary centres of excellence and progressing student-built satellite programs in universities and academic institutions. The student-built satellite activity at Technion University was taken as a case study to highlight how the program's scientific experiments went on to become the forefront of Israel's technological innovation and paved the way for paved the way for the rapid expansion of Israel's high-tech industries.

He also said that, in Israel we could not launch eastward with the rotation of the earth like everybody. Finally we launched it westward instead of eastward and we lost 30 percent of its capability but still had to monitor the launcher because it's way over the Mediterranean was a risk-taking of dropping an empty stage after it finished burning on god forbid a sheep or a territory and we wanted to take care of everything. So to build and launch a satellite we needed that time expensive infrastructure to support the efforts such as ground control station integration and testing and so on and today it is available even to primary and secondary school in Israel and we share it with our friends in the 75 Student's Satellites Mission. If we go a step forward and combine foreign companies to this kind of start-up it can be very successful and that's how we built our launcher from scratch.

Concluding his address, Prof. Eshed dwelt upon the Indo-Israel strategic alliance that included synergy with ISRO for PSLV as the main launcher for Israel's satellites, ITCA's 75 Student Satellite Mission 2022, and how these space initiatives would leverage the technological advances taking place in artificial intelligence, cloud and quantum computing, nanosatellite constellations and aerial platforms amongst others.

Brig Gen (Res) Prof Chaim Eshed, at **Inaugural Function of ITC 2019, 04 September 2019, Bangalore.**

L to R: **Dr Wooday P Krishna,** National President, IIPE, **Dr LV Muralikrishna Reddy,** Chairman, ITC, **Dr Ashwath Narayan C N,** Hon'ble Deputy Chief Minister, Government of Karnataka, **Brig Gen (res) Prof Chaim Eshed, Prof R M Vasagam,** Padma Shri Recipient, Chairman, National Advisory Committee, ITC2019, **Ms Dana Kursh ,** Consul General of Israel to South India, **Dr P V Venkitakrishnan,** Director - Capacity Building Programme Office, ISRO

Future Launch

Upcoming Launches by Global Space Agencies

27 September 2021

United Launch Alliance Atlas V Rocket

United Launch Alliance Atlas V rocket will launch the NASA/U.S. Geological Survey (USGS) Landsat 9 satellite

Launch Site & Time:
Vandenberg Space Force Base in California
2:11 p.m. EDT (1811 GMT)

30 September 2021

Epsilon Rocket

JAXA will use an Epsilon rocket to launch the Rapid Innovative Payload Demonstration Satellite 2 (RAISE 2), a technology demonstrator

Launch Site & Time:
Uchinoura Space Center, 8:48 p.m. EDT

Q4 2021

SSLV

An ISRO Small Satellite Launch Vehicle (SSLV) rocket will launch the Demo 1 mission. The launch date is currently targeted for Q4 2021

Launch Site & Time:
Satish Dhawan Spaceport, Shriharikota, TBD

October 2021

SpaceX Falcon 9

A SpaceX Falcon 9 rocket will launch 51 satellites for the company's Starlink broadband internet constellation

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 40, TBD

October 2021

SpaceX Falcon Heavy

A SpaceX Falcon Heavy rocket will launch the USSF 44 mission for the U.S. Space Force. It would deploy two spacecraft payloads including the military's TETRA 1 microsatellite.

Launch Site & Time:
Kennedy Space Center - LC-39A, TBD

16 October 2021

United Launch Alliance Atlas V 500 Series

A United Launch Alliance Atlas 5 rocket will launch NASA's Lucy spacecraft. Built by Lockheed Martin, Lucy will fly-by seven Trojan asteroids, a family of asteroids that orbit the sun.

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 41, 5:34 am

31 October 2021

SpaceX Falcon 9

A SpaceX Falcon 9 rocket will launch a Crew Dragon spacecraft with 3 NASA astronauts and one ESA astronaut on-board to the International Space Station.

Launch Site & Time:
Kennedy Space Center - LC-39A, TBD

November 2021

United Launch Alliance Atlas V 500 Series

A United Launch Alliance Atlas 5 rocket will launch the STP-3 mission for the U.S. Space Force. Comprising STPSat 6 satellite and several small satellites.

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 41, TBD

November 2021

Boeing CST-100 Starliner

A United Launch Alliance Atlas 5 rocket, designated AV-082, will launch Boeing's CST-100 Starliner spacecraft on second unpiloted test flight to the International Space Station.

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 41, TBD

November 2021

United Launch Alliance Atlas V 500 Series

A United Launch Alliance Atlas 5 rocket will launch the USSF 8 mission with the fifth and sixth satellites for the Space Force's GSSAPin geosynchronous orbit, designed to help the military.

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 41, TBD

November 2021 — **SpaceX Falcon 9**

A SpaceX Falcon 9 rocket will launch the Turksat 5B communications satellite for Turksat, a Turkish satellite operator.

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 40,, TBD

17 November 2021 — **SpaceX Falcon 9**

It will launch the NASA's Imaging X-ray Polarimetry Explorer. IXPE exploits the polarization state of light from astrophysical sources to provide insight to our understanding of X-rays

Launch Site & Time:
Kennedy Space Center - LC-39A, TBD

04 December 2021 — **SpaceX Falcon 9**

A SpaceX Falcon 9 rocket will launch a Dragon 2 spacecraft on its fourth cargo resupply mission to the International Space Station.

Launch Site & Time:
Kennedy Space Center - LC-39A, TBD

December 2021 — **SpaceX Falcon 9**

A SpaceX Falcon 9 rocket will launch the Transporter 3 mission, a rideshare flight to a sun-synchronous orbit with numerous small microsatellites and nanosatellites for commercial and government customers

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 40, TBD

08 January 2022 — **United Launch Alliance Atlas V 500 Series**

A United Launch Alliance Atlas 5 rocket will launch GOES-T, the third geostationary weather satellite for NASA and NOAA.

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 41, 4:33 pm - 6:33 pm ET

January 2022 — **SpaceX Falcon Heavy**

A SpaceX Falcon Heavy rocket will launch the USSF 52 mission for the U.S. Space Force. The mission will launch an unspecified military payload on this mission

Launch Site & Time:
Kennedy Space Center - LC-39A, TBD

February 2022 — **United Launch Alliance Atlas V 500 Series**

A United Launch Alliance Vulcan Centaur rocket will launch the Peregrine commercial lunar lander for Astrobotic. The Peregrine robotic lander will carry multiple experiments for NASA

Launch Site & Time:
Cape Canaveral Air Force Station - SLC 41, TBD

Early 2022 — **Vega C**

An Arianespace Vega C rocket will launch the LARES 2 satellite for ASI, the Italian space agency. This will mark the inaugural flight of Europe's new Vega C rocket. Delayed from mid-2020 by coronavirus impacts.

Launch Site & Time:
ZLV, Kourou, French Guiana, TBD

Early 2022 — **Ariane 5**

Arianespace will use an Ariane 5 ECA rocket, designated VA257, to launch the MEASAT 3d and GSAT 24 communications satellites. GSAT 24 is a direct-to-home TV broadcasting satellite for ISRO

Launch Site & Time:
ELA-3, Kourou, French Guiana, TBD

March 2022 — **SpaceX Falcon 9**

A SpaceX Falcon 9 rocket will launch the first two World View Legion Earth observation satellites for Maxar Technologies to deploy six commercial World View Legion remote sensing satellites

Launch Site & Time:
LC-4E, Vandenberg Space Force Base, California. EDT

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Investor's Point of View

Investment opportunities for SmallSats

Akiba Penkar
Director
SYMBA MAZ Business Consotium
Israel

The small satellite industry has seen tremendous growth over the last few years. Technological advances in microelectronics have helped small satellites match the performance of larger satellites. Small satellites are affordable to build, test and launch, and have created an opportunity to build constellations. These constellations are creating new use cases in agriculture, defense, business intelligence, forestry, and disaster management.

With governments and national space agencies evaluating constellations of small satellites, and commercial customers preferring smallsats for their lower costs, speed of development, and agility, it is obvious that these satellites will unify the world in ways we have never imagined, creating opportunities for new breakthroughs.

Global investment Scenario

According to the nanosatellite industry tracking website, nanosats.eu, more than 3400 nanosatellites and Cubesats have been launched into orbit as of 20 August 2021. Business entities and organizations are launching constellations for applications including telecommunications and high-speed space-based internet services, and earth observation.

Industry reports peg the global small satellite market size at about USD 2.8 billion in 2020 to USD 7.1 billion by 2025 with a CAGR of 20.5%. These satellites are characterized by shorter development cycles and smaller project teams, and hence can be developed at a fraction of conventional satellites. Innovation and technological advances in computational technologies and data analytics have driven the miniaturization of satellite systems.

Research by MAZ Investments, an Israel-based techno-engineering project appraisal organization shows that satellite communication and space-based internet services; mapping and navigation; earth observation and remote sensing; and science and exploration are some of the lucrative segments in the New Space economy.

Smallsats can be built using Commercial-off-the-Shelf (COTS) hardware components and technology. Microelectronic innovations such as control sensors and actuators, trans-receivers, multi-spectral imagers, panels, and antennas would play a major role in enhancing efficiency of small satellites and making it easier to assemble and test. New Space leaders including Virgin Galactic, Blue Origin and SpaceX are developing reusable launches that can be used for multiple flights, slashing the cost of satellite development, and increasing their adoption.

MAZ Investments has also been tracking the expanding role of venture capital and private investors in the New Space industry. The investor profile is diverse with business angels, corporate ventures, venture capitalists, space enthusiasts considering investments with a wide range of investment objectives-business angels supporting a start-up in mid to long-term and venture capitalists exploring the possibility of quick financial results.

MAZ Investments is of the opinion that start-ups and investors would focus on provisioning global services (including communication, earth observation, remote sensing and IoT) that are sold to a larger number of users.

Industry analysts point out that while the dominant idea in New Space is vertical integration, there could be a trend towards the externalization of non-core business tasks (example- Ground Segment as a Service) with virtual networks of ground stations.

Wall Street industry reports have pointed out to their clientele that the New Space economy is likely to more than triple in the next decade and become a USD 1.4 trillion market. It is opined that New Space economy is growing "because space is being seen as a viable industry to invest in" by multiple classes of investors-public companies that are focused exclusively on space, public enterprises with exposure through a space subsidiary and private businesses which may either go public or spin off divisions (CNBC report, November 2019).

Another trend that has been noticed is that investments in space-based application companies is on an upward curve while investments into space infrastructure companies (those that build rockets and satellites) has seen a drop.

Global Case study: Israel's Experience in Small Satellites

Israel has been a pioneer in the development and launching of high-performance nanosatellites and traces its strength to the strong linkages with academia and the industry to develop on the continuing innovation cycles in the domain of aerospace and defence. Israel's space industry has been unique in that it has developed significant expertise on a modest budget and in an academic environment.

Israel has championed the creation of an ecosystem where there is a flow of information between universities, schools, and engineers with the objective of creating a talent pool of student innovators to take forward scientific and technological innovations in the country.

Engagement with ITCA

ITCA has been at the forefront of building partnerships with Israeli Universities which could be utilized by Indian Institutions and Universities. Leadership of Indian Universities and Institutions were very keen on introducing programmes that could bridge the gap between the curriculum and the expectations of industry and were proponents of Practice-based Learning methodology.

Reaching students earlier in their educational development cycle is critical in developing a workforce to remain competitive in the global marketplace. Therefore, teachers in high schools must engage students in Science, Technology, Engineering and Mathematics (STEM) curriculum earlier to generate interest, develop skills and provide the educational foundation for students to build upon.

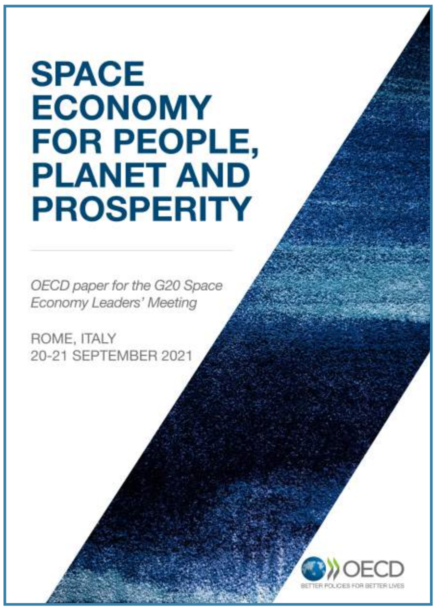
This was in resonance with our education pedagogy followed in Israel and it was possible for us to build the structure for introducing student-built satellite programs for Indian institutions in partnership with Israel. We also noticed that the major impediment to progressing these projects was the limited access to funds.

ITCA and 75 Satellite Mission

ITCA has initiated the ambitious "75 Students' Satellites Consortium: Mission 2022" to commemorate the "75 Years of Indian Independence"(1947-2022) by launching 75 student-built satellites into orbit in conjunction with national and international tech-space organizations. ITCA has collaborated with various professional organizations worldwide, including TMISAT-Israel, Israel Aerospace Industries, etc.

Investment Prospects

SYMBA-MAZ a business entity in Israel with global operations including India has structured affordable funding mechanisms for institutions and universities to progress student-built satellite programmes. It has aggregated a single-window process where institutions desirous of progressing student satellite activity could gain access to state-of-the-art technology, mentors to guide the student and faculty teams, and institutions to gain access to affordable funds. SYMBA-MAZ in partnership with ITCA is positioned strongly to progress the student-built satellite program in India and build a culture of innovation and technological excellence in the future workforce of the country.



This latest publication is outcome of G-20 Space Economy Leaders Meeting just concluded at Rome, Italy prepared by Organisation for Economic Co-operation and Developments Space Forum

Key Messages

As key components of the world's growing digitalisation, space technologies will play a role in furthering social well-being and sustainable growth in the post-COVID-19 pandemic recovery. Notably, space technologies can contribute to bridging the digital divide, monitor changing climate, extreme weather and the use of natural resources, and create new economic opportunities.

However, a number of challenges need to be addressed before G20 economies can make the most of what space technologies have to offer. Skills and gender gaps in the space-related workforce, and a need to improve on-the-ground digital infrastructures, are common issues.

Moreover, the unprecedented intensified use of Earth's orbits is threatening the orbital environment and its space infrastructure, with debris accumulating yearly. With a growing societal reliance on space-based infrastructure and systems, debris-related incidents and collisions could have significant negative consequences globally.

Decision makers need to better understand and map the use of space technologies in government services and society as well as future needs, and identify and address key hurdles to technology uptake and sector development, such as skills gaps and availability of personnel, so as to ensure the cost efficiency and sustainability of critical space infrastructure. This will require concerted efforts across multiple government services and between countries, as well as expanding cooperation with the private sector.

Several G20 economies have made great progress in the economic measurement of their space activities, contributing to enhance awareness of the contributions of the space economy to the economy and to the accountability of public spending in this area. These activities contribute to better understanding and evaluating the impacts of government investments and will prove useful for underpinning future government investments and policy decisions.

Source: oecd.org

Women Pioneers in Space programmes

Space exploration in its early years did not have women as part of the plan. While it is commonplace today for men and women to work with the national space agencies, circa 1950s required a struggle for women to participate in any space program.

The first woman to travel to space was Soviet cosmonaut, Valentina Tereshkova. On 16 June 1963, Tereshkova was launched aboard the spacecraft Vostok 6 on a solo mission. She spent 70 hours orbiting the Earth. It was no cakewalk for Tereshkova to be selected as a cosmonaut, she had to distinguish herself from 400 other candidates who had applied to the cosmonaut corps. Tereshkova underwent 18 months of rigorous training with the then Soviet Air Force after selection to hone her skills in handling challenges including emergency management and the isolation of being in space alone. Tereshkova till today holds the record title as the youngest woman and the first civilian to travel in space.

In the USA, Frances "Poppy" Northcutt was the first woman to work as technical staff for the Apollo program. Working in the Mission Control's Mission Planning and Analysis room, Northcutt and her team formulated and developed the return-to-Earth trajectory that the Apollo 8 crew took to return from the Moon to Earth. Her singular contribution to the Apollo 8 was to ensure accuracy in the calculations that lowered the amount of fuel used to swing around the Moon. Apollo 8 became the first crewed mission to ever leave the Earth's orbit, reached the Moon successfully, orbited it and then returned to Earth safely on 27 December 1968. She was awarded the Presidential Medal of Freedom Team Award for her work on Apollo 13 mission.

As has been chronicled by the National Aeronautics and Space Administration (NASA), Sally Ride was the first American woman in space, and flew aboard the Space Shuttle STS-7 in June 1983. Some of the other notable firsts by women include:

Other notable firsts

- Roscosmos cosmonaut Svetlana Savitskaya was the first woman to participate in a spacewalk on July 25, 1984.
- NASA astronaut Mae Jemison flew on the Space Shuttle Endeavour's STS-47 mission in 1992, becoming the first black woman in space.
- NASA astronaut Susan Helms was the first female crew member aboard the space station, a member of Expedition 2 from March to August 2001.
- NASA astronaut Peggy Whitson was the first female ISS Commander, starting April 2008, during a six-month tour of duty on Expedition 16.
- The most women in space at one time (four) happened in 2010, when space shuttle Discovery visited the space station for the STS-131 mission. Discovery's crew of seven included NASA astronauts Dorothy Metcalf-Lindenburger and Stephanie Wilson and Japan Aerospace Exploration Agency (JAXA) astronaut Naoko Yamazaki. The space station crew of six included NASA astronaut Tracy Caldwell Dyson.
- Susan Helms shares the record for longest single spacewalk, totalling 8 hours 56 minutes, with fellow NASA astronaut Jim Voss.
- Expedition 24 marked a first with two women, NASA astronauts Shannon Walker and Tracy Caldwell Dyson, assigned to a

Ref: https://www.nasa.gov/mission_pages/station/research/news/whm-recent-female-astronauts

The United Nations General Assembly has declared "World Space Week" as an annual event between October 4 and 10 commemorate two important dates in space history: the launch of the first human-made Earth satellite, Sputnik 1, on 4 October 1957; and the signing of the Outer Space Treaty on 10 October 1967. World Space Week is officially defined as "an international celebration of science and technology, and their contribution to the betterment of the human condition" and is observed from October 4-10 in over 95 nations across the globe.

It is reckoned as the largest annual space event in the world.

For more information, visit https://www.worldspaceweek.org/

space station mission from April to September 2010.

- The 2013 astronaut class was the first with equal numbers of women and men.
- NASA astronaut Anne McClain became the first woman to live aboard the space station as part of two different crews with other women: Serena Auñón-Chancellor in 2018 and Christina Koch in 2019.
- NASA astronauts Jessica Meir and Christina Koch completed the first all-female spacewalk in October 2019. They conducted two more spacewalks together in 2020.

As of March 2021, 68 women have flown in space, including astronauts, cosmonauts, space station participants, and payload specialists. Russian Federation, Canada, Japan, European Space Agency (ESA), China, Korea and Sweden are the other nations who have deputed women to travel to space. In addition, women have participated in scientific research on the International Space Station and have contributed to the technological advances achieved in the program. Kalpana Chawla, an American astronaut and engineer, was the first woman of Indian origin to travel to space. Sunita Williams and Sirisha Bandla are the other women of Indian origin who have travelled to space. Dr. Swati Mohan, Yogita Shah, Priyanka Srivastava and Zainab Nagin Cox who have contributed significantly to the success of landmark space programmes.

In 2019 Beth Moses became the first woman commercial astronaut to travel to space (sub-orbital). NASA astronaut Megan McArthur is currently serving as Pilot of the NASA SpaceX Crew-2 mission to the ISS, launched on 23 April 2021.On 16 September 2021, Sian Proctor and Hayley Arceneaux became the first female commercial astronauts to orbit on Inspiration.

Impact of COVID19 on Space Industry

Satellite-based information and data are becoming increasingly important in societies' effective running and economic development as the world digitalizes. The sector's recent expansion has resulted in unprecedented levels of entrepreneurship and startup activity. Investments in space programmes help to foster scientific discovery, technological advancement, and breakthroughs in commercialized digital experiences. More than 80 countries already have space programmes, and they are continuously spending substantially in space missions because they perceive the potential for substantial economic gains and competitive advantage for nations.

The socioeconomic catastrophe caused by the COVID pandemic, in addition to the confinement of citizens globally, may have impacted the trajectory of space exploration in the same way that all other business sectors experienced, with severity varying depending on the endeavour. The postponement of launch dates, the closure of several satellite production lines, the shutdown of academia and universities, and the lack of accessible financing have perplexed space players, creating business uncertainty and doubt amongst customers, employees, partners, and investors.

While many space sector businesses appear to be coping with time, a substantial number are struggling, particularly small-sized enterprises, which make up most commercial players in the space industry. More significantly, the groupings of startups, incubators, and universities participating in SmallSat development, which is a critical source of innovation and experimentation, are taking longer to recover from the COVID shutdown.

The Indian enterprise, particularly the country's most popular national space agency, ISRO, has been impacted as a result of the COVID pandemic and the slow recovery by partners in the space ecosystem. Many programmes, including a few launches, have been delayed and eventually rescheduled, including the ambitious Moon mission. While there were five launches in 2019, only two took place in 2020, and one this year from the Satish Dhawan Space Centre in Sriharikota. Other major launches and progressive plans of Indian space missions are likely to see changes to the intended schedules as the partner ecosystem needs to get back to a full-fledged contributory mode. Over the last two years, ISRO has gone beyond its established mandate to help the ordinary citizen by ensuring the availability of oxygen concentrators to provide assistance at the peak of the COVID crisis, earning good-will from all.

Because of the ISRO's lucrative and affordable launch options, many countries rely on India's capabilities to launch their small satellites. India has launched 342 such satellites for 34 nations over the last two decades. The pandemic has also significantly influenced commercial space companies, primarily startups and academic organizations developing experiential SmallSats, including Nano and Cube.

Similarly, ITCA's 75 Student Satellite mission has been deferred since academia has been shuttered for over two years, with faculty and students not being available on campus to implement such complex missions.

ISRO Initiatives

On the path to Atmanirbhar Bharat

Dr K Sivan
Chairman, ISRO
Secretary, DOS

Sri R Umamaheswaran
Scientific Secretary
ISRO

Sri Radhakrishnan D
Chairman & Managing Director
New Space India Limited

Dr Pawan Kumar Goenka
Chairperson
IN-SPACe

112 Spacecraft Missions (/list-of-spacecrafts)*

82 Launch Missions (/launches-sdsc-shar-sriharikota-india)**

12 Student Sate;;otes (/spacecrat/list of-university-academic-institute-satellites)

2 Re-entry Missions (/list-o-re-entry-missions)

342 Foreign Satellites***

* Including 3 Nano Satellites, 1 Micro Satellite

** Including Scramjet-TD, RLV-TD and Crew Escape System

*** of 34 Countries

The global space economy is currently valued at about USD 360 billion. Despite being one of the few space faring nations in the world, India accounts for only 2% of the space economy.

In line with the Prime Minister's vision of promoting private sector activity in all high-technology areas including space to unlock the potential of India's youth and entrepreneurs, ISRO has initiated reforms to enable private entities within the Indian space sector to establish themselves as independent players capable of end-to-end space activities.

The implementation strategy identified by ISRO to open the space sector for private participation includes:

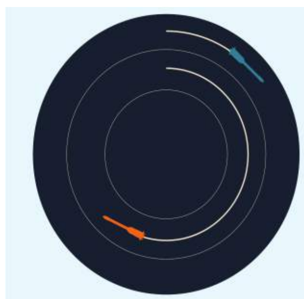
- Building of launch vehicles and satellites
- Sharing of ISRO facilities
- Establishment of facilities in the Department of Space (DOS)' premises
- Launch campaign and launch
- Space-based services

Provide a Stable Regulatory and Policy Environment

The reforms have strengthened the policy-making capacity of the Department of Space and an exercise has been initiated to create new business-friendly policy frameworks in areas like remote-sensing, satellite communication, and launch policies.

Announcement of Future Opportunities for Private Sector

The reforms have tasked ISRO with identifying and announcing future opportunities in selected science and exploration missions for private sector participation. Such participation will be promoted through part funding by the government. ISRO will also share best-practices, protocols, and other relevant technical expertise with the private sector to enhance their capacity for space activitie



Indian space contribution
2% of global market share

Potential to capture
95 of global market share by 2030

% of global market share

US	**40%**
UK	**7%**
India	**2%**

Global space economy	**USD 360B**
India (in 2019)	**USD 7B**
India to grow (by 2024)	**USD 50B**

Transfer of Technologies from Public to Private Sector

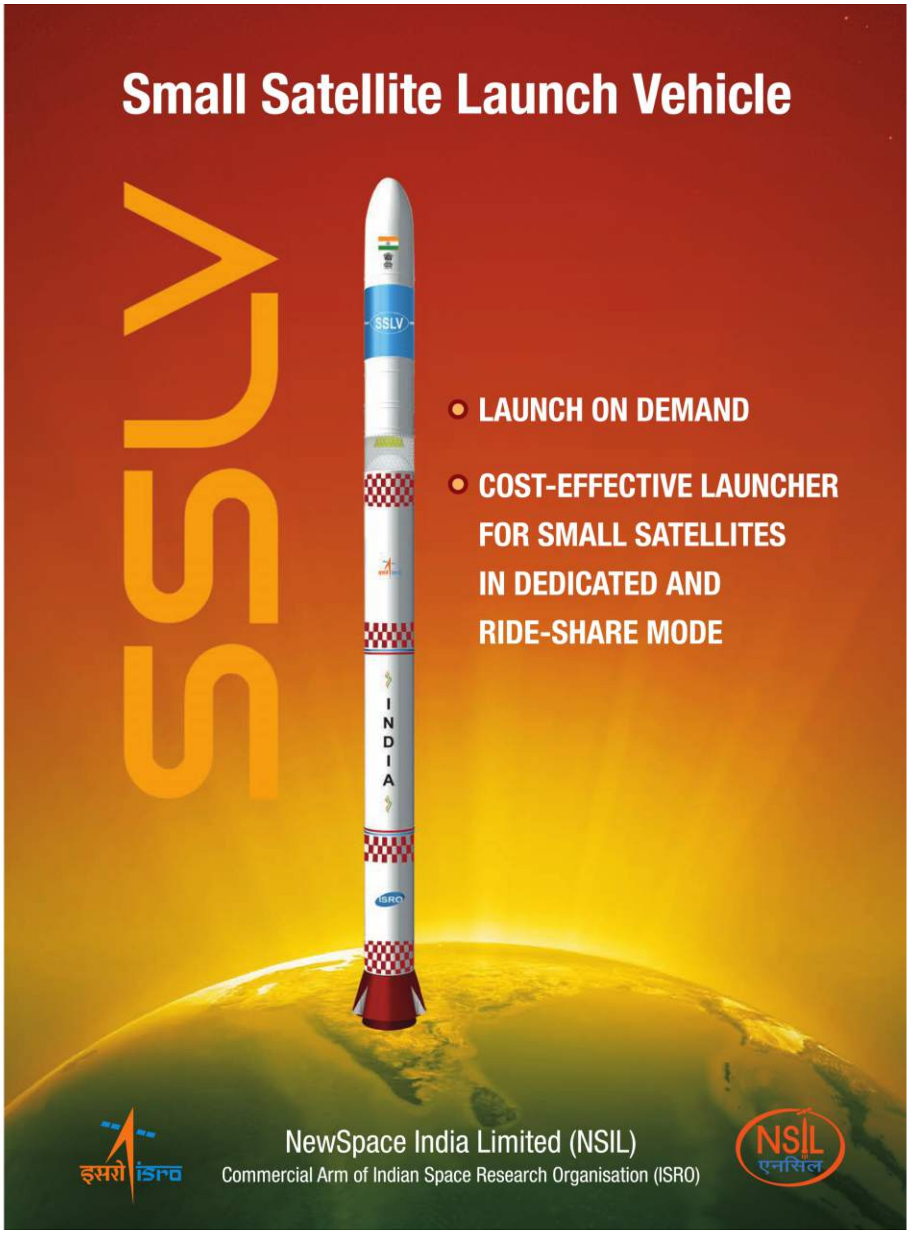
The reforms have authorized the public sector company NSIL to act as the exclusive public-sector aggregator for both demand and supply of space assets/ services on a commercial basis, including imaging, communication transponders, launch services etc. In its role as a demand aggregator, NSIL will acquire satellites, launch vehicles, and other assets developed by ISRO or the private industry. In its role as a supply aggregator, NSIL will commercialize assets and services like transponder capacity, imaging services, launch capacity etc, on ISRO-developed satellites and launch vehicles.

Platforms such as Polar Satellite Launch Vehicle (PSLV) and Small Satellite Launch Vehicle (SSLV) have been identified for transfer of technology to the private sector in the near future.

Ref: ISRO's Publication on Space Reforms "Unlocking the Space Sector"

New Space India Ltd

A Govt of India Company under Department of Space



NewSpace India Limited (NSIL), a Government of India company under Department of Space and the commercial arm of the Indian Space Research Organization (ISRO), will be the sole nodal agency responsible for providing end-to-end SSLV Launch services for the customer satellites starting from contractual, technical, programmatic, launch campaign, launch and post-launch activities.

The major business areas of NSIL include:

- Production of Polar Satellite Launch Vehicle (PSLV) and Small Satellite Launch Vehicle (SSLV) through industry
- Production and marketing of space-based services, including launch services and space-based applications like transponder leasing, remote sensing, and mission support services
- Building of Satellites (both Communication and Earth Observation) as per user requirements
- Transfer of technology developed by ISRO centres/ units and constituent institutions of Dept. of Space
- Marketing spin off technologies and products/ services emanating out of ISRO activities
- Consultancy Services

Ref: NSIL Website; NSIL's SSLV Technical Brochure

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UNISEC INDIA — University Space Engineering Consortium

TMIsat — The Maz Israel Satellite and Aerospace Technologies Ltd

BRICS

WCRC

World CanSat Rocketry Championship

КРСП/CSPD — Комитет за развој свемирског програма

VALLES MARINERIS — space innovation and beyond

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Indicative List of Global Satellite Manufacturers

Since the launch of the first satellite Sputnik-1 into an elliptical low Earth orbit (LEO) in 1957, there are about 3,372 active artificial satellites orbiting the Earth as of 1 January 2021. Industry analyst reports highlight that as of 16 September 2021, about 1,400 new satellites have already begun circling the Earth.

At an industry event last September, NITI Aayog member Dr V K Saraswat opined that small satellites would dominate the global space sector and revealed that 7000 small satellites were expected to be launched by 2027, with a total value of USD 38 billion.

New Space Era has created opportunities for start-ups and entrepreneurs to enter the exciting area of CubeSat and nanosatellite manufacture. ITCA's incubated start-ups TMISat in Israel and TSC Technologies in India have entered this exciting area of nanosatellite manufacture and have been successful in achieving early successes.

The following indicative compilation highlights some of the leading CubeSat and SmallSat companies that have been in the news.

Organization	Website
Adcole Maryland Aerospace	https://www.adcolemai.com
Airbus Defence and Space	https://www.airbus.com/space.html
Astroscale	https://astroscale.com/
Boeing Defense, Space & Security	https://www.boeing.com/space/
Endurosat	https://www.endurosat.com/
GAUSS Srl	https://www.gaussteam.com/
GomSpace	https://gomspace.com/home.aspx
Harris Corporation	https://www.l3harris.com/en-in/india?regional_redirect=en-in
Iceye	https://www.iceye.com/
INVAP	https://www.invap.com.ar/en/
ISIS (Innovative Solutions in Space)	https://www.isispace.nl/
Israel Aerospace Industries Ltd.	https://www.iai.co.il/
JSC Information Satellite Systems	http://www.iss-reshetnev.com/
Lockhed Martin Space	https://www.lockheedmartin.com/en-us/capabilities/space.html
Maxar Space	https://www.maxar.com/
Millennium Space Systems	http://www.millennium-space.com/
NanoAvionics	https://nanoavionics.com/
Northrop Grumman	https://www.northropgrumman.com/space/
NSLComm, ISRAEL	https://www.nslcomm.com/
OHB SE	https://www.ohb.de/en/
OneWeb	https://oneweb.net/
Planet Labs	https://www.planet.com/
Pumpkin Space Systems	https://www.pumpkinspace.com/
Raytheon	https://www.raytheonintelligenceandspace.com/
Satixfy	https://www.satixfy.com/
Spire	https://spire.com/
Surrey Satellite Technologies	https://www.sstl.co.uk/
Swarm	https://swarm.space/
Thales Alenia Space	https://www.thalesgroup.com/en/global/activities/space
TSC Technologies Pvt. Ltd	https://tsctech.in/
Tyvak	https://www.tyvak.com/

Intelligence, Surveillance and Reconnaissance Satellites

Global space missions contribute significantly to comprehensive socio-economic goals besides scientific capacity building and are extremely helpful for national security and surveillance. With the rise in global threats and incidents, the way armed forces execute their ISR operations has evolved drastically. In today's world of increasing global hardship, Intelligence, Surveillance, and Reconnaissance (ISR) is increasingly being utilised to monitor in real-time battle devastation while also enabling foreign policy measures to combat terrorism. Real-time information sharing and prompt transmission of information acquired in the field is vital to mission accomplishment. The growing relevance of information-based military operations, as well as the huge need for real-time situational awareness, is expected to drive the demand for (ISR) satellites in the future. As a result, this segment will make up the bulk of worldwide military space-based spending during the following decades.

Because most modern surveillance systems have a limited operational life, the military satellites sector is expected to spend more resources replacing older space technology with newer ones. The industry is also changing in response to technological advancements, lower costs, and shorter manufacturing periods. Because of breakthroughs in miniaturisation, the cost of building satellites has significantly dropped, allowing nations with limited resources to focus on domestic development. With evolving international political scenarios, defence forces' demand for small satellites is expected to progressively increase, with military organisations upgrading the capabilities of their satellites to boost operational capabilities.

Globally, several nations' military and defence departments are focused increasingly on deploying SmallSats for ISR capabilities. The US Department of Defense (DoD) has created a committee to oversee small satellite activities throughout the department and services, with intentions to invest in 100 small satellites (source SATELLITE 2021 conference)

The Boeing Company, Israel Aerospace Industries, Northrop Grumman Corporation, ISS-Reshetnev, SpaceX, Lockheed Martin Corporation, Raytheon Company, Thales Group, Mitsubishi Electric Corporation, and GE Aviation are the significant competitors in the military satellites industry.

Given the increasing demand and necessity for national security solutions, ISR systems for both surface and underwater surveillance are being implemented. Many governments worldwide have had significant success by using modern ISR technologies such as satellite reconnaissance, unmanned aerial systems, and sensor platforms. These intelligence and surveillance solutions come in various forms, including optical, radar, infrared, pictures, and electronic signals, and can be sent via portable devices or orbiting satellites.

The worldwide military satellites market is anticipated to reach $61.56 billion in 2025.

Upcoming Global Space Events

UK Space Conference - Virtual Event
27 - 29 September 2021
https://www.ukspace.org/event/uk-space-conference-2021

International Communications Satellite Systems Conference (ICSSC)
27 - 30 September 2021, Arlington, Virginia, USA and virtual
https://www.kaconf.com

SATCOMS
27 September - 1 October 2021, London, UK
https://satcoms.theiet.org

Ka and Broadband Communications Conference
28 - 30 September 2021, Arlington, Virginia, USA and virtual
https://www.kaconf.com

SATCOMS
27 September - 1 October 2021, London, UK
https://satcoms.theiet.org

The Space Summit
30 September - 1 October 2021, Boston, USA
https://selectbiosciences.com/conferences

CyberSatGov
5 - 7 October 2021, Aerospace Corporation and Hyatt Regency Reston, Virginia, USA
https://www.cybersatsummit.com/

Satellite Innovation
5 - 7 October 2021, Computer History Museum, Silicon Valley, California, USA
https://2021.satelliteinnovation.com

Space Tech Expo USA
6 - 8 October 2021, Long Beach, California, USA
http://www.spacetechexpo.com

Space + Terrestrial - the IoT Connection
7 October 2021, virtual event
https://www.century21comms.com

NAB Show
9 - 13 October 2021, Las Vegas, Nevada, USA
https://www.nabshow.com

SPACEtalks
19 October 2021, London, UK
https://www.spacetalks.biz

International Symposium on Antennas and Propogation
19 – 22 October 2021, virtual Event
https://www.isap2021.org

PocketQube Workshop
21 - 22 October 2021, TBD
https://www.pocketqubeworkshop.com

Space Generation Congress
21 - 23 October 2021, Dubai, UAE
https://spacegeneration.org

INDIAN TECHNOLOGY CONGRESS

India-International On-line Event held during 24-25 September 2021

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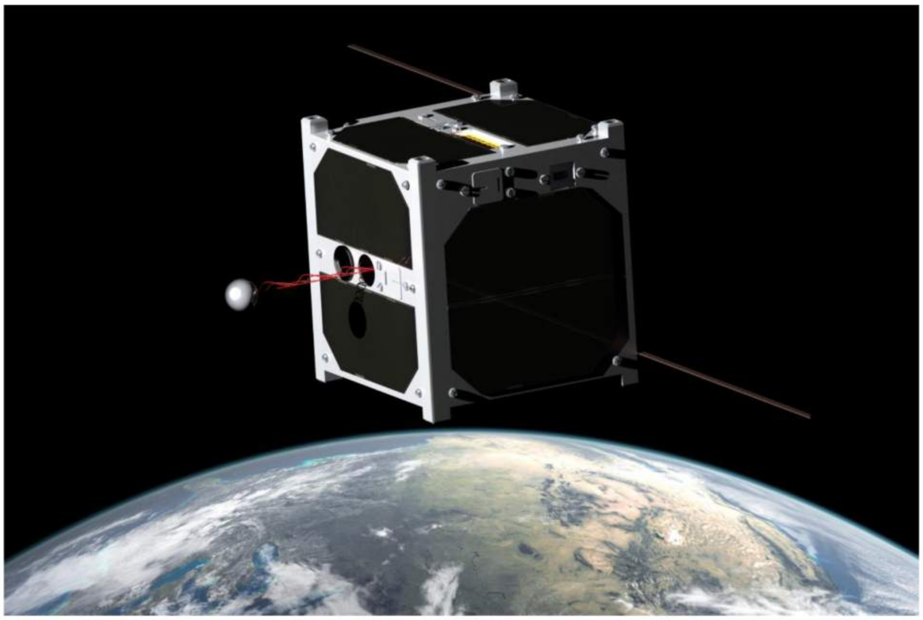

***For More Details:* Er. Dušan Radosavljević, Founder and Head, CSPD, Serbia/WCRC**

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Space 4.0: Pathways for Commercial Exploitation

The industrial revolution (Industry 4.0) over the last few years is influencing the space sector. The investments being made today to drive innovation in R&D and contemporary production processes would generate wealth tomorrow and in the future.

The first era of space, 'Space 1.0', can be considered to be the early study of astronomy (the Sun, Moon, and stars). The next era, 'Space 2.0', came about with rocket technology, development of satellites and culminating in the race for Moon landings in the 1960s. Space 3.0 emerged in the 1990s with the establishment of the International Space Station and identification of space as the global destination for co-operation and partnership.

Today, we are in the early years of Space 4.0, based on contemporary innovations and new space applications that are democratizing access of space for all citizens, and with immense potential to drive global growth.

Till a few years ago, space was characterized by government spending: the high costs and the risks associated with space exploration restricted the sector to space agencies of governments, and with minimal opportunities for private sector participation. We are now seeing a paradigm shift with the advent of contemporary technological advances and a resurgent entrepreneurial spirit that is shaping a new space economy. Space 4.0 is witnessing the entry of start-ups, entrepreneurs and private businesses, participation by academia, and citizens, leveraging the overarching structure of digitalisation and global interaction.

According to Microsoft the processing of data collected from space at cloud-scale to observe the Earth will be "instrumental in helping address global challenges such as climate change and furthering of scientific discovery and innovation".

The value of data from space should be assessed from the perspective of vendors in the public and private domains who produce and consume such data. With the satellite launch costs having reduced, access to satellite data becomes easier and open to commercial markets, which in turn will usher in enhancement of the quality of our lives, improved safety and preservation of the earth.

Space is growing at a fast pace, and we are likely to see more than 1200 satellites being launched per year in the next 3 years (2022-2025). While the positive news is that space is globalizing with more space fairing nations, the cautionary notice is that space is getting crowded, and that space could transition from a benign environment to a contested one.

Space additive manufacturing is likely to emerge as a game changer in Space 4.0 given its potential to enable production of low-cost satellites, lighter and efficient rockets to take cargos into orbit, and facilitate human space travel. The recent achievements by global space players have brought in an era of commercial human space travel.

Additive manufacturing (AM) is a critical technology as it enables manufacturers to optimize weight of systems built to reach space. AM can help in slashing the cost of commercial space activities by pushing the envelope to develop advanced materials, replace metals hitherto used in spaceborne systems, and promote the use of high-performance polymers and composites.

The possible availability of construction metals (metals, water, etc.) in space on surfaces of planetary bodies or asteroids provided an option to use additive manufacturing to build colonies, settlements, and other infrastructure elements without having to carry prefabricated structures out of the Earth's gravitational field. Use cases of AM can also include manufacturing replacement components in space, and recycling in space, reducing the mass that must be carried from Earth.

While AM technology seems to have immense potential, the challenges that will need to be addressed are qualification and certification of 3D manufactured space hardware to withstand harsh environments and limited options for repair; availability of electricity in spacecraft to drive 3D printing units; feasibility to automate 3D printing processes for set-up, support, and post-processing as these rely on human participation.

Some of the critical issues that will require a wider debate amongst the extended stakeholders include the commitment to sustain investments in space and satellite capabilities for global benefits; methodologies to protect the space environment; architecture and development of space systems for interoperability; and methods to progress space operations in a sustainable manner.

To thrive on the challenges, we will need to proactively progress initiatives on multiple fronts and addressing the aspirations of all stakeholders. This would require a close integration of the society and economy built on a solid foundation of innovation in science and technology.

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