Published by
INDIAN TECHNOLOGY CONGRESS ASSOCIATION

Volume 9 ‖ Issue 3 ‖ September 2022

TIP

TECHNOLOGY
INNOVATION
PRODUCTIZATION

NEWSPACE

From Policy to Practice

75 Students' Satellites Mission

Azadi Ka Amrit Mahotsav

आज़ादी का अमृत महोत्सव

75 Students' Satellites Mission

ITCA's Engineering Prowess and Ingenuity

INDIAN
TECHNOLOGY
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NEWSPACE

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75 Students' Satellites Mission

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TECHNOLOGY INNOVATION PRODUCTIZATION
Volume 9 || Issue 3 || September 2022

Mission

Encourage interdisciplinary thinking by disseminating curated scientific and engineering knowledge to stimulate and inspire Indian engineering and technology ecosystem

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Published by

Indian Technology Congress Association
www.itca.org.in

Designed and Printed by

Foundation for Education Excellence

Cover Page

AI-created collage capturing the fantasy of travel and objects in space, portraying NewSpace potential. "TIP" depicts James Webbs Telescope's "Pillars of Creation" showing star formation.

This publication is a collaborative effort between ITCA and the 75 Students' Satellites Mission.

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Policy to Practice

New Normal of Space Sector

Editor-In-Chief

L V Muralikrishna Reddy, PhD
President
Indian Technology Congress Association

Engineer's Day is observed on 15 September to commemorate the birth anniversary of Bharat Ratna Sir M Visvesvaraya, the nation's most distinguished engineer and statesman. Engineers have been instrumental in the scientific, technological, and industrial revolutions that have fundamentally changed human civilisation over the course of millennia, all the way up to the present knowledge society in which we live. India is fortunate that its engineering fraternity's technological brilliance, ability, and competence have positioned the nation as a shining example of its progressive ideals and socio-economic aspirations. The remarkable contributions of Indian engineers, scientists, and technocrats across diverse domains, including space, have propelled the nation to rank among the top 50 innovative economies in the world, according to the Global Innovation Index (GII). On this year's Engineer's Day, we honour their accomplishments and bestow our publication on their incredible efforts.

While the pandemic slowed many human endeavours in recent years, it has not impeded technological advancements. On the other hand, the society's tenacity and perseverance enabled it to overcome the COVID-19 challenges and grow more robust. At the same time, most professions resumed their routine activities, at times excelling. Similarly, scientists, researchers, and entrepreneurs in the space sector have effectively proven and conceptualised the greater use of Outer Space to advance life on Earth. The global space industry has clearly gained impetus since the beginning of this year, with 120 successful launches and more than 1250 satellites deployed in orbit. Most of these are orbiting near the Earth's surface, addressing critical societal demands and illustrating LEO's growing significance for space activities.

These triumphs are propelling technological advances powered by human ingenuity. For instance, Boeing completed an orbital flight test of its CST-100 Starliner; and China has magnificently docked the Wentian lab module with the Tiangong space station. Rocket Lab delivered a NASA mission to the moon, and South Korea launched its first domestically produced rocket, and many other noteworthy events were seen. Scientific missions to the planets, a slew of Mars rovers (including the first robotic helicopter), and a variety of sophisticated space-based observatories are unravelling the mysteries of the universe.

SpaceX has successfully deployed 3,162 Starlink satellites in LEO, demonstrating its prowess in establishing mega-constellations. SpaceX's high launch frequency and minimal turnaround time of their workhorse rocket, the Falcon 9, have showcased the precision and maturity of the design capabilities. We also witnessed the success of India's flagship Polar Satellite Launch Vehicle (PSLV), reiterating ISRO's ability to launch satellites from other nations. This positions India as a cost-effective partner for foreign countries to progress numerous space missions.

Over the last few years, private enterprise participation in the global space sector has increased tremendously. As the space frontier expands in scale, thousands of satellites are circling the Earth daily to provide services such as GPS signals, weather and climate data, communication, and internet access. The number is only expected to rise exponentially in the emerging NewSpace era. As a consequence of the potential offered by these advancements, there is an increased need for innovation, skill and resources, to strengthen global space competencies. To capitalise the space opportunities, nations are building synergistic alliances between the government, R&D organisations, industry, and academic institutions. Countries are also working on policy reforms to make interactions across the stakeholders more seamless and inclusive in the context of ensuring benefits for the global community. Space-faring nations are enacting new laws and regulations to further these activities in line with best practices for adhering to current treaties and conventions.

Semiconductors played a vital role in the creation of the modern world, as seen by the prevalence of chip-containing gadgets. Today semiconductor chips have grown so vital that nations are capitalising on them. This will disrupt global geopolitical, military, and economical operations and cause shortages when combined with challenges like a pandemic, impediments including raw material availability, etc. On the other hand, with so many influencing elements, the semiconductor industry could overtake the oil glut as the world's leading economy in the following years, depending on how the imperative conditions unfold.

Strong supply chains that accommodate enterprises with a long-term commitment should be the

industry's gold standard for any sector. The current semiconductor supply chain challenges are having a contagion effect across sectors of the global economy, including the space industry. While advanced economies compete for dominance in this domain, investments in the burgeoning business are accueil. Semiconductor fabrication plants have the propensity to become focus sites for innovation, localisation of industry and skilled labour. To meet future demands, establishing public-private partnerships is vital to the growth of these fab-centric ecosystems.

This month, the prestigious International Astronautical Congress2022(IAC) on the topic "Space for @ll" will be held in Paris to expand the global space community and bring together main stakeholders on a shared platform to provide chances for networking and boost future collaborations. Participation by over 250 exhibitors and more than 6000 registrations at the IAC makes it a fantastic venue for making new connections and discovering new business prospects. We are ecstatic that the ITCA is facilitating an Indian delegation to build new partnerships for enduring space projects.

The Indian space industry is well-known worldwide for producing low-cost satellites, launchers, Lunar and Mars excursions, and deploying foreign spacecraft. India is predicted to march into new frontiers as globally the sector expands to a size that might reach one trillion US dollars, propelled by the urge for innovation, a favourable investment environment, and progressive government policy initiatives. The Department of Space (DOS) established the Indian National Space Promotion and Authorization Centre (IN-SPACe), which was inaugurated in June 2022 in Ahmedabad, Gujarat, by the Honorable Prime Minister of India. It intends to develop an ecosystem for private businesses to use Indian space infrastructure. IN-SPACe is encouraging the private industry through supportive policies and establishing a conducive regulatory environment. This brilliant initiative will boost India's space industry and in turn contribute for national economy to achieve the desired USD 5 trillion mark.

India is developing a strong space ecosystem and positioning itself as a global hub through inclusive growth, public-private collaborations, and commercialisation. India is working with the UN to improve the framework of existing accords to address the present issues of NewSpace-extensive deployment of satellites in LEO, satellite servicing, space traffic management, tourism, and space debris mitigation.

The Bengaluru Space Expo 2022, organised by the CII in partnership with ISRO, IN-SPACe, and NSIL, held in September 2022, is yet another big moment for Indian space technologies. The concurrent International Conference on "Nurturing the NewSpace in India" gave a chance for Indian space entrepreneurs to showcase their competencies. Australia, the United Kingdom, and the Netherlands presented their space business capabilities and explored future collaboration opportunities with the Indian industry, including startups. According to sources, many agreements and memorandums of understanding have been signed, empowering the internationalisation of Indian space.

Semiconductors are the quintessence of modern and future electronics, with myriad applications, including space-based assets. The Government of India's thrust on self-reliance in electronics and semiconductors through the "Semicon India" will ripple effect on the Indian private sector space initiatives. We will likely see the strengthening of indigenous capabilities in designing, manufacturing, and launching rockets and satellites of different sizes & classes.

Globally, the CubeSat sector is undergoing a "faster, better, and affordable" transformation. ITCA has established a robust space ecosystem through its flagship 75 Students Satellite Mission, which encourages the establishment of creative enterprises, startups, and research institutions while also acting as a catalyst in the realisation of next-generation satellites through academia across the country. ITCA is extending its mission beyond teaching ensuring generations of space enthusiasts to encompass the development of technical and commercial influences for the future decades.

The collaboration we are working on with the Karnataka state government to enhance students' awareness of space in state-run schools and institutions is rewarding. More than two lakh students have enrolled to compete in the "75 Sats Quiz, Essay, and Painting Competition" hosted by ITCA-KSTePS-KSCST. This contest is being run as part of the PUNEETHSat Mission's outreach programme. These initiatives seek to increase students' awareness of space exploration and motivate them to participate in the development of CubeSats. This one-of-a-kind programme has garnered praise from space enthusiasts all around the world.

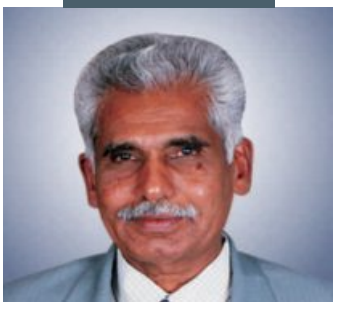
We highlighted the advantages of student-built CubeSats for versatile learning and contributing to developing NewSpace capabilities in this TIP issue. The articles are adroitly penned, and we invite you to join us on an immersive reading journey into the worlds of NewSpace, SmallSats, and associated technologies.

ITCA, through its collaborative space-tech quests and missions, will assist in reaching a broader audience and developing India's strategic advantage in outer space. We work diligently to provide comprehensive information to citizens through a shared vision, intending to create a resilient ecosystem to improve life on Earth.

SPACE

Reimagining the Future of Learning

Advisor
75 Students' Satellites Mission



Prof R M Vasagam
Vice President
Indian Technology Congress Association

Education is getting transformed at all levels with increasing emphasis on experiential learning. The Experimental Learning Model comprising of five steps: Experience, Share, Process, Generalize, and Apply. The first step Experience requires the learner to engage in an activity in order to learn. It is in this context that the 75 Students' Satellites Mission with its emphasis on hands-on learning becomes an ideal candidate.

The ITCA promoted initiative to bring in teams of school and college students to build, launch, and operate 75 small satellites in near-earth orbits comes handy to enhance experiential learning. These satellites weighing over 1.0 kilogram carry payloads to gather data from IoT sensors, and establish inter-satellite links to demonstrate the constellation mode of operation for global coverage. The developments have been enthusiastically envisioned by the Prime Minister and supported by many public and private educational institutions across the country. It is fortuitous that we are able to celebrate the 75 years of India's Independence in this year with Indian student community to contribute in their own way in attaining self reliance in this sector with theory and practice going concurrently.

The programme blends design and development of a small satellites with 10cm X 10cm X 10cm dimensions consisting of structure, thermal, power, attitude sensing and control, tracking telemetry and command and payloads. This allows interplay of various science and engineering disciplines giving a chance to learning by doing using systems engineering tools. The AICTE guideline facilitating selection of interdisciplinary electives by undergraduate engineering students has come at the right time. The National Education Policy also emphasises similar approach. Promoting entrepreneurship is another plus point of the 75 student Satellite mission.

While this initiative is going full stream, the opening up of Indian Space Programme has come in at the opportune moment. The setting up of IN-SPACe to promote private participation in space efforts, access to ISRO facilities and authorising setting up infrastructure, technology transfer and production of proven space systems by private entities are some key points of these reforms. To get at least 10 % share in world space market currently estimated at 440 Billion USD is a goal set for this laudable initiative.

All this needs highly qualified and well trained human resource to come out in this emerging field. The small beginnings made by California Polytechnic (Cal Poly) mentored by Stanford University and NASA Ames paved the way for CubeSat revolution in 1998 is a landmark event. In their footstep, universities and schools across the world have built and launched close to 3000 small satellites with rewarding outcome in science, engineering and societal applications. India has taken the first step by building the Anna University satellite and has followed it up with the development and launch of satellites by other educational institutions including the IITs and leading engineering colleges.

The 75 Students' Satellites Mission comes during the historic occasion of celebrating 75 years of Indian independence, and reflects the nation's ambition to become a global player in delivery of space systems and services. Students who are interested in pursuing careers in this dynamic industry have the opportunity to participate in and take the lead on global communication and remote sensing satellite constellation projects being undertaken by major players such as Space X, Amazon, OneWeb, and Asian countries such as South Korea, Japan, and China. The construction of hyperspectral imaging satellites in constellation mode is where Indian start-up companies got their start. Now, many Indian entrepreneurs are focusing on the services component of the SpaceTech industry, and are developing applications to process satellite data. There is significant economic potential that is 90 percent untapped.

The provision of launch services at prices that are economically appealing has encouraged a new breed of startup companies to construct launch vehicles with the assistance of venture financing. This is another activity that ought to be brought to the attention of the SpaceTech aficionados. IN-SPACe has begun providing assistance for such projects in the interest of single window facilitating clearance, and results will follow in the not too distant future.

Under the auspices of ITCA, I would like to extend my warmest sentiments and best wishes to the students, professors, management, and institutions who are working together to make this groundbreaking initiative a success.

Marwadi University

Marwadi Chandarana Group

GUJARAT'S FIRST UNIVERSITY
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IN ASSOCIATION WITH **ITCA**
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Systems Engineering
Leads Space Missions

Systems Engineering's (SE) primary goal is to enhance the useful life of complex systems. A space mission involves launch vehicles, ground systems, payloads, and variety of components that must be assembled, integrated, tested, and authenticated before being deploying into orbit. This requires a rigorous engineering approach that can be verified throughout the mission's life cycle. Conventional space missions are made up of well-established SE tools and processes, and a majority of these are standardized by national space agencies who have dominated this overwhelming sector for the last 60 years. In the contemporary CubeSat era, the role of value-added SE approaches has grown in importance to accomplish the desired outcomes. As there are many engineering fields involved in designing and deploying space systems, SE is in the driving position to become the most significant discipline for realizing these systems.

Satellite engineering and design is a well-known and well-understood subject. Many of the traditional methods and processes have been formulated and utilized in the context of design and characterization of larger satellites. Since the characteristics of SmallSats vary from those of bigger satellites, with volume being a primary restriction, the SE process will be highly complex and distinct. Among other design and performance limitations of SmallSat subsystems and payloads, the tiny size and its associated constraints on power generation and storage capabilities are an important factor.

SE is a way for assessing a system's overall performance in relation to a set of predetermined objectives appropriately adopted for the development of next generation SmallSats including CubeSats. This is particularly important because there are size, volume, and mass constraints that need to be considered while addressing the stakeholders' expectation of demanding functionality in the reduced footprint of SmallSats.

SE is intended to ensure that all mission team members collaborate to build complicated subsystems that are flawlessly integrated to realise the final satellite. It is expected that when the spacecraft is integrated and tested as a whole, it should operate at the performance levels envisioned by the designers by accomplishing the mission goals. The emphasis of SE is to ensure that the developed product meets the requirements by validating the interfaces, as well as the assembly and tracking of components in multiple phases throughout the project lifecycle.

Given the specific features of SmallSats and, in this instance, CubeSats, having shorter development timelines, and increased risk acceptance, there is a need to ensure that quality and reliability are at optimum levels. To do this, digital engineering techniques are being used to improve the effectiveness of SE implementation while maintaining its rigour. Contemporary model-based systems engineering (MBSE) tools and simulation functionalities are employed and integrate it into the technical baseline, which comprises requirements, design, analysis, interfaces, implementation, and verification. These tools are effective in structuring strong SE processes that will slash development cost and schedule, while enhancing speed and agility of the design process.

Satellite system verification is often a structured and formal process following a unit-subsystem-system sequence. The Assembly, Integration and Testing (AIT) phase, that extends up to launch involves a series of production activities and a plethora of tests that are meticulously planned and executed to ensure the reliability of the CubeSat. AIT is a multi-disciplinary activity that integrates expertise from different engineering disciplines.

Various approaches were adopted by different national space agencies to deploy SE. For instance, the National Aeronautics and Space Administration (NASA) defines SE as a systematic and disciplined set of procedures used recursively and iteratively for the design, development, operation, maintenance, and closeout of systems across the project/program life cycle. It is a method of meeting stakeholder functional, physical, and operational performance criteria in the intended use environment within cost, schedule, and other limitations during the system's projected life.

The European Cooperation for Space Standardization (ECSS) is a partnership between the European Space Agency (ESA), the European space industry, which is represented by Eurospace, and several other space agencies. Their goal is to create and maintain a single and consistent set of standards that can be used in all European space activities with refernce to SE. The ECSS has 139 active standards that make up for space projects missions. The ECSS standards will apply as needed to any party participating in the definition, development, manufacturing, verification or operation of any equipment, subsystem, system or service used for the European element of any space mission.

The Japan Aerospace Exploration Agency (JAXA) made SE norms to make sure that products meet the needs that stakeholders have defined as engineering requirements. The SE standards also stress the need to keep track of the trade-offs between cost, schedule, and quality. This is in order to make a system that is aligned and to reduce the risks that throw off-balance

the cost, schedule, and quality triad. The standards for JAXA also emphasize the necessity of using past experience and lessons learned to avoid errors.

To assure reliability, quality, and standardisation, the Indian Space Research Organizations(ISRO) and its centres adhere to the customised SE standards covering several disciplines of engineering that fall under the name "ISRO Technical Standards (ITecS)".

SE for 75SSM

The Mission adopted the global best practices that had been employed by space organisations in the development of CubeSats, in particular under the guidance of DOS agencies of ISRO, NSIL, and IN-SPACe. The Mission teams has been extremely encouraged by the motivating advice and presentations delivered by eminent SE experts who have been working in the filed of aerospace and aeronautics.

A significant number of the recommended finest practices are being implemented within the 75 Student's Satellite's Mission (75SSM) in order to bring about systematic design and development procedures. These have proved useful in fulfilling the crucial needs of the traceability spanning mission idea through development of subsystems, and in moving forward to the realisation of a functional CubeSats.

The development of a robust review mechanism through the constitution of 'Systems Engineering Committees' for assessing manufacturing readiness and review of test methodology and results, and flight readiness have been instrumental in creating a structure to ensure reliability of CubeSats developed for the mission.

Excerpts from Lt Gen (Dr) V J Sundaram...

DRDO's Missile programmes are most successful defence Missions that have extensively used SE practices in realizing the systems that were subsequently productized and large scale manufacturing. These programmes were conceptualized to develop self-reliance and build capacity for the Indian aerospace & Defence. This Projects under these programmes achieved substantial progress in developing indigenous launch vehicles and missiles, in an era that was often recognized for embargoes and denial of critical technologies by the developed nations.

ITCA has made considerable progress on making the standard SE processes for its ongoing programme on development of student-built CubeSats, and pursuits in space technologies.. In this context, ITCA organised an interactive session with Lt Gen (Dr) V J Sundaram, one of India's veteran and successful SE practitioners. He has contributed a lot to the development and use of SE to deliver successful aerospace programmes. The intent of the session, which took place on 25 May 2022, was to encourage 75SSM teams to gain insights about SE and the best ways to use it in space programmes, particularly when building SmallSats.

Key learnings

- Emphasis on overall system design, exhaustive use of PERT/CPM, identification of critical paths, interactions between users and projects, and progressing the projects in a 'mission' mode
- Importance of developing the concept of operations, conducting feasibility studies, and utilizing SE practices
- Focus on indigenous design, development, and manufacture of systems
- Need to develop critical technologies and use a robust procurement policy to identify and use key components with assurance of quality and reliability
- Use of SE methodologies across the entire product lifecycle, encompassing all phases including concept, design, development, testing, deployment, training and implementation
- Maintaining focus on addressing the needs of the users, and factoring in user-interactions
- Importance of having an effective project management structure, with adequate scope for reviews, and participation by all stakeholders
- Internalize and practice "4Ts", namely truth, trust, transparency, and timeliness

Lt Gen (Dr) V J Sundaram, PVSM, AVSM, VSM (Retd), led the Flight Vehicles design team for PRITHVI Missile Project in 1982-83 and was its first Project Director (1983-89), guiding its induction into the Army with 95% indigenous content. From 1992 to 1997 he was Director of both Defence Research and Development Laboratory (DRDL) and Research Centre Imarat (RCI) with overall responsibility for all Indian Missile Projects and was the Chairman of the Programme Management Board of the Integrated Guided Missile Development Programme (IGMDP).

New Trajectory for Indian Space
Unveiling IN-SPACe

Prime Minister Shri Narendra Modi inaugurated the Indian Space Promotion and Authorisation Centre (IN-SPACe) headquarters in Ahmedabad on 10 June 2022, enabling private sector engagement and invigorating innovation in the expanding space domain. The inaugural ceremony also witnessed the signing of Memorandums of Understanding (MOUs) between IN-SPACe and few organisations engaged in the area of space-based technology, applications and services.

India's ever expanding private sector has a wealth of expertise, knowledge, and resources to address the diversified demands of the space industry. The burgeoning space sector, with its endless prospects and untapped potential, has culminated in a landmark decision by the union cabinet headed by the Prime Minister to implement reforms that will increase competitiveness and encourage Indian private sector engagement across the entire spectrum of space operations.

As a consequence, IN-SPACe was founded and is intended as a single-window, independent, nodal organisation working as an autonomous agency of the DOS to enable private sector engagement.

IN-SPACe is also tasked with promoting, enabling, authorising, and supervising a variety of space activities, such as developing launch vehicles and satellites, providing services, sharing existing DOS/ISRO controlled facilities, and establishing new infrastructure.

In order to accomplish the aim of positioning India as a global space hub and a technological gateway for manufacture, launch, and ground operations, IN-SPACe is also facilitating Indian space enterprises, academia and start-ups. Additionally, the agency closely working with the Ministry of Foreign Affairs to identify and address space-tech needs in certain nations.

IN-SPACe is collaborating with various ministries & departments of the governments, and non-government entities whose primary mission is to advance research & development in space science & technology. Agency also engage with international public and private organisations that are interested in the acquisition of specialised services, such as the development and launch of satellites.

Excerpts from PM's Speech...

"Today a wonderful chapter has been added in the development journey of modern India of the 21st century. I congratulate all the countrymen and especially the scientific community for the headquarters of the Indian National Space Promotion and Authorization Center i.e. IN-SPACe. Whether they are working in the government or in the private sector, IN-SPACe has come up with great opportunities for all.

While initiating reforms in the space sector, I always had the immense potential of the youth of India in my mind. I was pleased to listen to the young boys taking steps forward in the start-ups with high spirits. I congratulate all these young people. The youth of India were not getting as many opportunities in the space sector earlier. The youth of the country bring with them innovation, energy and spirit of exploration. Their risk-taking capacity is also very high. It is very important for the development of any country. Today, when the youth of India want to become a participant in nation building, we cannot put a condition to him that it has to be done through the government route only. Our government is removing every obstacle being faced by the youth and is reforming continuously.

Before coming here, I was going through the IN-SPACe's Technical Lab and Clean Room. Here state-of-the-art equipment for the design, fabrication, assembly, integration and testing of satellites will be available to Indian companies. Many more modern facilities and infrastructure will be created here which will help in expanding the capacity of the space industry.

Today I also got a chance to visit the exhibition section and interact with people from the space industry and space start-ups. I remember when we were initiating reforms in the space sector some people were apprehensive about private players joining the space industry. But today more than 60 Indian private companies have joined the space sector and are leading it. I am very happy to see them today. I am proud that our private industry colleagues have moved rapidly in the areas of launch vehicle, satellite, grounds segment and space application. Private players from India have also come forward to manufacture PSLV rockets. Moreover, many private companies have even designed their own rockets.

"This is a glimpse of the limitless possibilities of India's space sector. I heartily congratulate our scientists, industrialists, young entrepreneurs and all the countrymen for this. And if I have to congratulate anyone the most for this new turning point in this whole journey, it is the people of ISRO. ISRO has taken giant steps and tried to move things rapidly for the youth of the country by offering them to join what was once its domain. This in itself is a very revolutionary decision.

We are celebrating the Amrit Mahotsav of 75 years of our independence. Behind our successes in independent India, which inspired crores of countrymen and gave them confidence, are our space achievements. When ISRO launches a rocket or sends a mission to space, the entire country becomes part of it and feels proud. The entire country prays for its success and every countryman expresses with joy, enthusiasm and pride when it is successful and considers that success as his own success. India's space mission has in a way been the biggest identity of 'AtmaNirbhar Bharat'. When this campaign gets a boost from India's private sector, you can imagine the potential of this campaign.

The use of space-tech is going to increase more and more in many such areas in the future. The IN-SPACe and private players need to ensure how to make space technology more accessible to the common man, how space-tech can become a medium to improve the ease of living and how we can use this technology for the development and potential of the country.

At present, the global space industry is worth about $ 400 billion. There is a possibility of it becoming a one trillion-dollar industry by 2040. We have talent as well as experience, but the private partnership is only 2 per cent. We need to increase our share in the global space industry, and our private sector has a major role in this. I can also see the strong role of India in the field of space tourism and space diplomacy in the near future. It will be a matter of pride for the whole country if India's space companies become global and we have a global space company.

The curiosity of our youth, especially the students, for space is a great force for the development of India's space industry. It is our endeavor that the students should be continuously acquainted and updated with the subjects related to space through the thousands of Atal Tinkering Labs built in the country. I would also urge the schools and colleges to inform their students about Indian institutions and companies related to space and organize their visits to these labs. The way the number of Indian private companies is joining this sector will also help them."

ITCA had signed and exchanged an MOU with IN-SPACe in the presence of the Honorable Prime Minister Shri Narendra Modi for the launch of 75 Student-built Satellites and a variety of space-related activities at this historic event. Also present, Hon'ble Union Minister for Home Affairs and Cooperation Shri Amit Shah, Hon'ble Chief Minister of Gujarat, Shri Bhupendra Rajnikant Patel, and the Member of Parliament Shri C R Patil witnessed the event.

MoU Signed Organizations with the Hon'ble Diginitaries

Dr K Gopalakrishnan, Secretary General signed and exchanged an MoU with Dr P K Jain, Director-PMA, IN-SPACe

ITCA Team with Shri S Somanath, Chairman, ISRO

ITCA Team with Dr Pawan Goenka, Chairman, IN-SPACe, Dr (Ms) Tessy Thomas, DG, Aeronautical Systems, DRDO and Shri Rajeev Jyoti, Director-Technical, IN-SPACe, Shri Prakasha Rao PJVKS, Chairman, PMC & Director, SIPO, ISRO HQ

The ITCA teams conferred with Hon'ble Prime Minister of India, Shri Narendra Modi, on 10 June 2022, during his visit to the ITCA stand at the Inauguration of IN-SPACe HQ in Ahmedabad, Gujarat and briefed about 75 Students' Satellites Mission.

Interaction with PM;

ITCA presented to PM about 75SSM

The 75 Students' Satellites mission, that you referenced at the 76th UNGA, is aimed at launching 75 student-built satellites into low earth orbit and setting up 75 networked ground stations and satellite labs across educational institutions in India. Through this initiative, we can demonstrate India's capacity in developing space technology at its grassroots. Integrating with reforms like the space policy and NEP we aim to build a workforce to contribute to a growing economy; startups through Initiatives like Make in India will make this decade a "techade" and we will be an Aatmanirbhar Bharat.

PM's Reflections

I want students to be able to access ***Atal Tinkering labs.*** *We've set up these labs across India and I'd like to see students working hands on in these labs. More such labs should be set up in the premises of schools and colleges.*

IN-SPACe Roles and Responsibilities

IN-SPACe being established as a single window nodal agency, with its own cadre, which will permit and oversee the following activities of Non-Government-Private-Entities (NGPEs).

- Space activities including building of launch vehicles and satellites and providing space based services as per the definition of space activities.
- Sharing of space infrastructure and premises under the control of ISRO with due considerations to on-going activities.
- Establishment of temporary facilities within premises under ISRO control based on safety norms and feasibility assessment.
- Establishment of new space infrastructure and facilities, by NGPEs, in pursuance of space activities based on safety norms and other statutory guidelines and necessary clearances.
- Initiation of launch campaign and launch, based on readiness of launch vehicle and spacecraft systems, ground and user segment.
- Building, operation and control of spacecraft for registration as Indian Satellite by NGPEs and all the associated infrastructure for the same.
- Usage of spacecraft data and rolling out of space based services and all the associated infrastructure for the same.

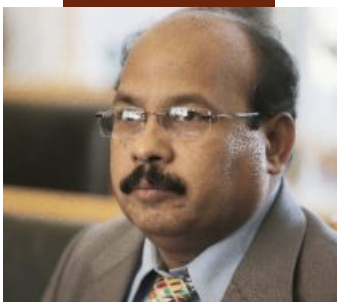
IN-SPACe will draw up an integrated launch manifest considering the requirements for ISRO, NSIL and NGPEs based on priorities and readiness level.

IN-SPACe will work out a suitable mechanism to offer sharing of technology, expertise and facilities on free of cost wherever feasible or at reasonable cost basis to promote NGPEs.

The decision of IN-SPACe shall be final and binding on all stakeholders including ISRO. A multi-disciplinary review and assessment mechanism comprising of four Directorates for Technical, Legal, Safety & Security, Monitoring & Promotion and will assist IN-SPACe in carrying out its functions.

Puneeth Satellite
A Unique Initiative

Member Secretary
PMC



K Gopalakrishnan, PhD
Project Director
75 Students' Satellites Mission
Advisor, Nagarjuna Group of Institutions/
Nagarjuna College of Engineering & Technology

As a part of the 75 Students' Satellites Mission initiated by ITCA to celebrate and commemorate 75 years of independence, and in line with the Hon'ble Prime Minister Shri Narendra Modi's reference at the UN General Assembly, the Hon'ble Minister for Higher Education, S&T, IT-BT, Skill Development Dr C N Ashwath Narayan, Government of Karnataka, announced the Karnataka Government School Students Satellite (KGS3Sat) Mission. It was later named "Puneeth Satellite".

The objective of this unique mission is to reach all the School Students (Primary/Secondary/PUC) in both Government & Private Institutions. Appropriate graded activities would be conceptualized and conducted in such a way as to inculcate and foster scientific temper among the students and also create awareness about the contributions of science/scientists and engineering/engineers in the nation building process along with the advancement of civilization.

Student Mobilization and Outreach Activities

As part of the outreach activities of this unique mission, Karnataka Science and Technology Promotion Society (KSTePS), and Karnataka State Council for Science and Technology(KSCST) are collaborating with ITCA to organize state level SpaceTech competitions under various categories across Karnataka covering all High Schools and PU Colleges. The objective of this outreach activity is to create awareness about space science &technology, and sensitize the students about "New Space Era" or "Space 2:0" which would offer them significant career opportunities over the next couple of decades.

KSCST under the leadership of Executive Secretary Shri H Hemanth Kumar and his team have done extensive preparations to participate in the following Competitions/Tests etc. Reading materials on Space, Launch Vehicles, and satellites in Kannada and English (soft copy/web links, etc) have been shared among all registered students from Schools in Karnataka.

The following are Contest/ Competitions for Government School Students and Private Schools (TWO categories).

- Quiz
- Essay Writing
- Painting
- Model Making
- Space Aptitude Test as Multiple Choice Questions/Tests etc

Winners from each category would have mentoring sessions/interactions with eminent space scientists.

Selection of students from various schools in Bengaluru, Ramanagara, and Kolar districts has been done and Orientation Programmes were carried out. After that, a screening test was conducted to choose students for competency-building programmes that included hands-on training with online/offline in space and satellite. Winners of KSCST Competitions on Space-Satellite-Rockets would be given preference to participate in Puneeth Satellite Trainings/Projects/ Visit to India's Spaceport Sriharikota during the launch of Puneeth Satellite. It was announced by the Hon'ble Minister that 1200 students who are

Hon'ble Minister for Higher Education, S&T, IT-BT, Skill Development **Dr C N Ashwath Narayan** with **Shri D V Sadananda Gowda,** MP, Bangalore North, Karnataka Science and Technological Academy Chairman, **Padma Shri Awardee Prof S Ayyappan** and KSTePS MD, **Shri A B Basavaraj IAS** have released the Handbook on CanSat to CubeSat with ITCA President **Dr L V Muralikrishna Reddy** Secretary General **Dr K Gopalakrishnan** and other dignitaries on the dais.

PUNEETH SATELLITE

INDIA'S FIRST

Government School Students Satellite by Govt. of Karnataka

Technical Evaluation Committee (TEC) Members of PUNEETH Satellite

- **Mr Prakasha Rao PJVKS,** Outstanding Scientist, Director, Space Infrastructure Programme Office, ISRO HQ, Chairman, Project Monitoring Committee (PMC) of 75 Students Satellites: Mission 2022
- **Mr Sura P S,** Programme Director Satellite Navigation Programme U R Rao Satellite Centre (URSC), Bengaluru
- **Mr Jidesh,** Associate Director SIPO, ISRO-HQ
- **Mr Veeresha D R,** Scientist/Engineer-SF, Thermal Systems Group, Mechanical Systems Area, U R Rao Satellite Centre (URSC)
- **Padma Shri Prof RM Vasagam,** Eminent Scientist, Project Director, APPLE
- **Padma Shri Dr Mylswamy Annadurai,** Outstanding Scientist, ISRO, Project Director, Chandrayaan & Programme Director, Mangalyaan
- **Mr GNV Prasad,** Former Deputy Director, U R Satellite Centre, ISRO
- **Mr Mahadevan V,** Eminent Scientist, Former Director, Mission Planning and Development
- **Dr Priestly Shan,** Dean (Academics), Chandigarh University
- **Mr A B Basavaraju, IAS,** Director (Tech), Dept of Electronics, IT, BT and Science and Technology/Managing Director, KSTePS
- **Dr T Venkatesh,** Scientist, KSTePS

Historical Response to Puneeth Satellite - Karnataka State Level Space Tech Competitions for Schools' and PU Colleges' participation through Registration is 2.5 Lakhs of Students. The event has been organized by 75 Satellites Mission of ITCA-KSTePS-KSCST-Govt of Karnataka to sensitize younger generations of students to strengthen STEM Education. It is a timely intervention by ITCA and KSTePS-KSCST, the Government of Karnataka.

Winners of all these Outreach Activities of Puneeth Satellite core students team trained and selected 1200+ Students of Karnataka Schools' will Visit Sriharikota to Witness the Puneeth Sat Launch and will be proudly flagged by Hon'ble Ministers of Karnataka!

winners of various space events/competitions will be given the opportunity to witness the launch of Puneeth Satellite in January-February 2023.

To create the environment at the host institution, Government School Premises, 18th Cross Malleshwaram; 16 foot-GSLV and PSLV Mockup Models have been installed.

Self-Driven Activities for All Schools/PU Colleges at 31 Districts of Karnataka

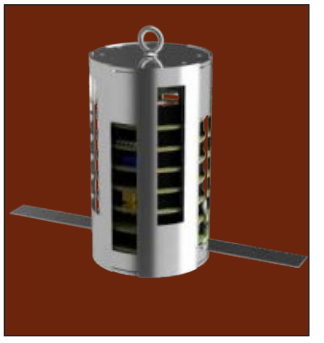
A calendar of various activities at each and every school has been compiled from the lists proposed, and these are being organised by the respective schools/PU colleges over 100 days from 20 August to 30 November 2022.

Outreach events planned for the entire state of Karnataka by KSCST-KSTePS-ITCA are being monitored by KSTePS MDShri A B Basavaraj IAS and his team with Dr Venkatesha R T, Scientist-SE periodically.

Experiential Learning through Development of CanSats

Hands-on Training on CanSat has been initiated. CanSats developed by students have been flown in two international events-UNISEC Global, Japan, and WCRC, Serbia over the last 5 months.

This experiential hands-on learning has helped students reinforce their



learning of various concepts.

Satellite Development

The preliminary design review (PDR) of the 1U PuneethSat was presented with the objective of familiarizing the stakeholders with the design philosophy of the various subsystems-On-Board Computer (OBC), Electrical Power System (EPS), Attitude Determination and Control System (ADCS), Communication System/Telemetry & Solar Panel, and Software Programming/Coding of Systems/Subsystems. This background would help students assimilate key concepts highlighted in the CubeSat themed lectures, and facilitate enhanced understanding of the design and functioning of SmallSats.

Following this, subsequent activities planned for the coming months include establishing the Ground Station at the host institution, and familiarizing students with the exciting opportunity to establish an amateur radio (HAM Club) in the premises.

LEO Satellites for 5G Network

ITCA's AI Creation

Geostationary communication satellites have been circling the Earth for more than 50 years, giving vital support to humanity. These massive satellites are placed in geosynchronous Earth orbit (GEO), at 36,000 kilometres above the planet's surface with each satellite weighing approximately 1000 kilograms. Cost, complexity, and development time, among other factors, will be key challenges in designing and deploying them in that orbit. Technical advances, notably the facets of digitalization and miniaturisation are making low-Earth orbit (LEO) satellites a pervasive method of next-generation communication. This is due to the fact that LEO satellites can send data at significantly faster rates than conventional GEO-based communication systems. The contemporary digital era, in which social, economic, and political activities are heavily dependent on information and communication technology, with internet access playing a critical role, is distinguished by a large dependence on these types of LEO satellites. LEO satellite constellations emulate the interoperability of fifth generation (5G) cellular networks significantly.

Today's LEO-satellite constellations, that orbit 500 to 2,000 kilometres above the Earth, offer reduced latency (and hence faster communication), and deliver higher bandwidth per user than conventional GEO satellites, significantly more than cable, copper, and pre-5G fixed wireless. The sheer numbers of technology deployment across the globe indicates that all these networks would theoretically envelope the planet in coverage and prevent any loss of connection. Furthermore, LEO satellites cover polar regions whereas GEO satellites do not. In contrast to GEO satellites, which may operate for more than twenty years, these shorter-life LEO satellite constellations would need a continual replacement cycle.

Several reasons have contributed to the increased interest in LEO satellite access in recent years. The development of disruptive technologies, such as reuse of rocket parts, has helped organizations like SpaceX slash launch costs, and has became a critical enabler of NewSpace. Meanwhile, the use of commercially available off-the-shelf (COTS) components and the use of lean principles in satellite design facilitates mass production with a shorter manufacturing cycle and lower price-points. The use of cutting-edge technology in satellite communications, such as multi-spot beam capabilities and powerful onboard digital processing, is now possible from a business perspective.

Emergence of Constellations of Private LEO Satellites

Typically, the ground coverage of a LEO satellite deployed at approximately 600 kilometres above the Earth's surface with an elevation angle of 30 degrees would be around 0.45% of the Earth's surface. Moreover, due to the low altitude of deployment, LEO satellites can communicate with diverse types of ground terminals. These include dedicated ground stations (GSs), ships and other vehicles, and the user segment, which refers to the remainder of communication devices such as IoT devices, smartphones, gateways, and cellular base stations. These features and elements create the need for a relatively dense constellation to ensure that any ground terminal is always covered by, at least, one satellite.

Tens of thousands of satellites are being launched by non-traditional, cash-rich, and high-tech entities in order to attain this ambitious aim. SpaceX has approximately 2,300 operational Starlink satellites in orbit as of September 2022, with a long-term goal of 30,000. The United States Federal Communications Commission (FCC) has approved Amazon's Project Kuiper to launch and operate a constellation of over 3,200 internet satellites. Initial plans for the OneWeb satellite constellation call for 648 internet satellites. These are examples of some of the major players driving this sector to greater heights.

Development and Capabilities of LEO Satellite Constellations

In terms of communication technology, both free-space optical (FSO) and traditional radio frequency (RF) can be utilized for intersatellite links (ISLs) and ground-to-satellite links (GSLs) between satellites and ground terminals. FSO links employ ultranarrow beams to combat the increased attenuation of high carrier frequencies with distance, thereby offering greater transmission ranges, higher data rates, and lower interference levels than RF links. Numerous scientific missions have demonstrated FSO ground-to-satellite communication links. A number of planned commercial LEO constellations, including SpaceX, Telesat, and LeoSat, will deploy laser communication equipment for high-throughput FSO ISLs. FSO is highly

pointing errors, which are some of the common disadvantages. Therefore, communication through FSO links necessitates a combination of precise pointing capabilities and pre-arranged pairing, so that the antennas of the intended receiver and transmitter transmit the beams in an appropriate manner.

The wider beams of RF links allow for their incorporation into terrestrial RF-based systems. Additionally, RF links are essential as a fallback solution if FSO communication is not possible, for instance due to positioning and pointing errors in the space segment, traffic overload, or poor weather. Consequently, a hybrid RF-FSO system has the potential to significantly improve network flexibility and dependability.

LEO satellite payload should be proportional to average intended traffic; however, platform power is frequently a barrier. This necessitates efficient power recharge capabilities during periods of light traffic (e.g., switching off most operational functions over poles and oceans to maximise the recharging phase with solar panels). ISLs can lower the total number of gateways on the ground, cut infrastructure and operational expenses, and service oceans outside coastal regions.

Numerous technology enablers have a high technology readiness level (TRL). TRL for specific design criteria is the most important feature of space-qualified technologies. For instance, onboard active antenna technologies are currently available, as demonstrated by the Starlink satellite's independently shapeable and steerable beams. Starlink satellites have about 8 to 32 beams that can be configured based on the mission needs. It is probable that the future LEO mega-constellations may require larger arrays or a greater number of antenna elements, necessitating more payload optimization and integration.

Numerous recent publications have provided a detailed examination of 5G requirements for the design of future satellite systems. Development of novel space-qualified RF and microwave components. such as high-efficiency power amplifiers based on gallium-nitride (GaN) and silicon-germanium (SiGe) technologies is likely to enable cost-effective integration of RF structures, and promises to emerge as a significant driver for technology adoption. Other advanced approaches, like as completely digital beamforming and beam hopping schemes, are also crucial for the design optimization of the satellite payload as a function of the power, mass, and cost-effectiveness budget for a particular service and traffic demand.

Beam-hopping techniques along with active antennas and onboard digital processors will be used by next-generation payload architectures to achieve dynamic switching of carrier frequencies, modifying bandwidth per carrier, adjusting power allocation per beam, and beam layouts almost instantly.

This implies that the radio resource management system must accommodate multiple degrees of freedom in a highly limited environment in order to determine the optimal allocation of system-level resources. Due to the dynamic nature of the system, in which satellites move relative to the earth and to one another, each allocation scheme must be virtually constantly recalculated. Appropriate radio resource management algorithms are crucial for enhancing the efficiency of a LEO constellation.

Standardization for Popularizing LEO Satellite Adoption

5G has provided options for new frequency bands, some of which overlap with the idle bands in sub-6G frequencies. The availability of tens of thousands of satellites in the near future will accelerate the exhaustion of limited spectrum, therefore pursuing higher frequency such as Ka bands is becoming a mandatory step in the technology upgradation roadmap. Since multiple verticals need significant spectrum resources, interference caused by reusing frequencies and sharing frequency band between different orbital planes and terrestrial stations will continue to be challenges that need to be addressed. Radio spectrum is still expensive for SatCom operators, and for pervasive technology adoption, dynamic spectrum resource sharing schemes should be developed and standardized. Research should also be done on advanced beamforming algorithms and digital signal processing techniques to effectively reduce interference.

Business-case for 5G Satellites

The satellite business has been behind the curve in adopting technological advancements taking place in the arena of communication. Significant time and effort were expended at the back-end to integrate new satellite technology with existing telecommunications standards and processes. LEO satellite constellations will supplement terrestrial 5G infrastructure to boost network coverage besides delivery of improved mobile broadband functionality. Next-generation IoT devices are delivering greater data rates and lower latency throughput using a constellation of satellites in the sky.

5G Services in India

In the coming days, India would be witnessing the beginning of a new era in technology with the launch of 5G services in the country. It is envisioned that the technology would facilitate seamless coverage of broadband internet with high data rates and low latency across the country. This would play a major role in achieving the Hon'ble Prime Minister's vision of making India a USD 5-trillion economy by 2024-25. LEO satellites will be vital to the spread of 5G networks across national boundaries and even beyond.

Global Partnerships
for Low-power Wireless Solutions

Sujay Narayana
Researcher (PhD),
Embedded Software Dept
TU Delft, Netherlands

Zero Energy Development (ZED) is a growing organization comprising of multidisciplinary team members from TU Delft, one of the world's leading research universities. ZED is a global SME from the Netherlands with operations in India, and has expertise in the field of battery-less & wireless applications, and Space Internet of Things (Space IoT).

Space is becoming enthralling day-by-day and it is the next frontier for innovations in IoT. Space Internet of Things is a concept that involves a network of satellites to address the main challenges in terrestrial IoT deployments – global coverage, scalability, and connectivity. SmallSats technology enables the next-generation space missions, which are agile, networked and wireless-communication enabled, closed-loop control systems to autonomously accomplish multiple tasks. Hence, miniaturization is a key element to the future vision of Space-IoT. Space-IoT is a game-changer for the future IoT, and it opens a world of new possibilities by providing global network coverage.

ZED's journey started after winning the prestigious Airbus Fly Your Ideas (FYI) competition in 2019 that has attracted interest from various aerospace industries to explore low-power wireless solutions. ZED has also won the Dutch 4TU Impact Challenge and represented the Netherlands in the world expo 2020 in Dubai.

ZED is a B2B IoT solution provider which enables enterprises to harness the potential of wireless and low-power applications in the context of terrestrial/SpaceIoT. These applications can range from inventory and freight management to data collection and predictive maintenance, with the unique differentiator being the ability to customize solutions based on the client's needs and facilitate seamless integration.

With more than 30 years of combined research experience in these domains, ZED enables enterprises to harness the potential of the next generation of Space IoT applications. Multinational and multidisciplinary team comprises scientists, engineers and commercial experts who bring years of technical and commercial experience to the table and we believe in the concept of "think big, be small".

The vision of ZED towards Space IoT is to seamlessly connect terrestrial IoT devices to the internet using a network of satellites operating as a swarm.

ZED's Co-founder **Venkatesha Prasad** and Strategic Advisor **Kiran Muthal,** CAMS met the Indian Ambassador, **His Excellency Mr Pradeep Rawat** to discuss the technology collaboration opportunities between India and The Netherlands. The ZED team briefed
H E Ambassador about ZED's work in IoT and battery-less communications, the awards by Dutch governments and ongoing projects in the aviation and agricultural sector. The recent collaboration between India and ZED in the field of space systems was also discussed during the meeting. The HE Ambassador assured his support for future collaboration with Indian universities and government establishments.

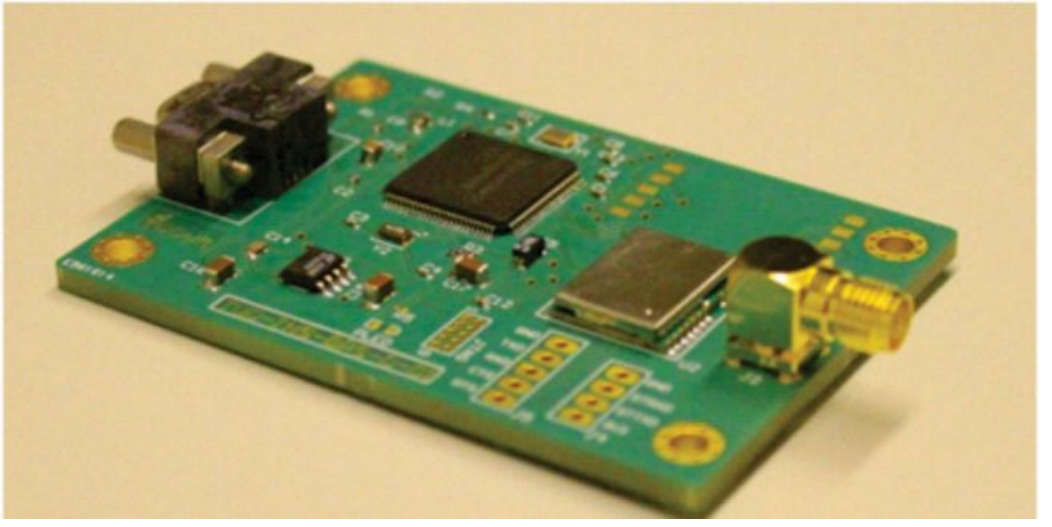


Fig. 1 GNSS Module

It is an interdisciplinary technology team that integrates expertise across different domains- mechanical, electrical, communication and importantly, embedded system,s and software engineering, making the enterprise a hotbed for innovation.

Space-IoT is a hot research topic in the satellite industry, and pioneering breakthroughs in technical innovations are essential to introduce products for commercial and mainstream deployment. ZED traces some new horizons for innovations in space embedded systems.

The team members of ZED, while working at TU Delft, have worked on low-power, miniaturized GNSS module for ISRO's three nanosatellites – INS-1A, 1B, and 1C. The modules performed very well in space as planned.

The GNSS module has the following features: GPS L1/GLONASS L1/Galileo constellation support, 40mm x 60mm form factor, UART/SPI/I2C for host communication, and 12m position accuracy. The first version of the GNSS module (Figure 1) that flew on INS satellites has helped establish the space heritage for our unique solutions.

As a follow-on extension of the solution offering, ZED have developed a diagnostic tool called as Chirper. This instrument is capable of providing many different health parameters of a space system without the need for any electrical contact. Chirper (Figure 2) is an independent subsystem that may run on the electricity provided by the parent satellite or its own solar cells for its operation.

It not only sends a beacon (telemetry), but it also includes information on the critical status parameters of the satellite, such as the battery voltage, the rotations, temperature of the satellite body and the state of other subsystems.

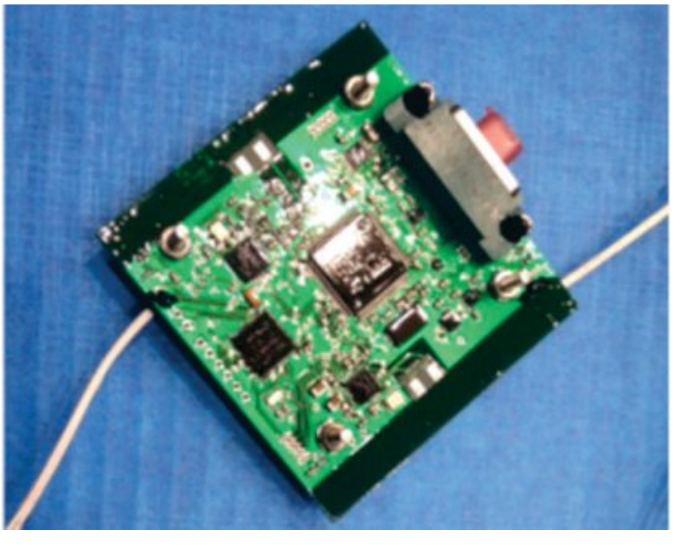


Fig. 2 Chirper

All the measurements are electrically contactless and `no modification or electrical connection' to the parent satellite is required.

The tracker is even able to recognize if there is weak telemetry from the main satellite without having wired connection to any of the satellite sub systems.

ZED has expertise in supporting ground station services. ZED team members have provided technical support for ISRO's INS-1C and INS-2TD via TU Delft and Indian business partners. Zed also plans to establish its own full-fledged ground station in near future.

ZED and ITCA have signed a joint collaboration agreement for the development and testing of innovative space projects, particularly those that can be launched on satellite or rocket stages. The areas under the collaboration include small satellite development including structures, mechanics, electronics and software.

ZED is enthusiastically looking forward to the fruitful outcome from the collaborations with ITCA and the 75 Satellites Mission that are part of "Azadi ka Amrit Mahotsav". ZED is also working closely with the ITCA Mission teams to customize the GNSS solutions for the 75 Students' Satellites Mission.

World CanSat Rocketry Championship

Gateway to Competency building in SpaceTech

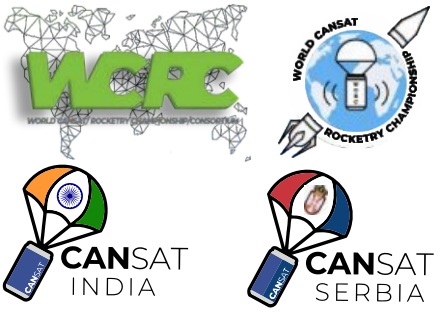
CanSats are well-known in academic circles, and their development predates that of CubeSats. It is often used to educate students on how a satellite is made and to practice the engineering, design, and coding skills that are important for STEM education.

CanSats have emerged as a structured methodology to familiarize students on contemporary space technology. This is achieved by an experiential activity that transforms a 350ml-beverage can into a functional simulation of a satellite.

CanSat championships present university and school student teams with a curated opportunity to participate in all phases of a real-life space project, including mission conceptualization, satellite design, fabrication, ground test, modification, launch, operation, and post-flight analysis and validation. The main advantage of the CanSat/Rocketry concept is its interdisciplinary flavour, with a blend of mathematics, physics, informatics/programming, mechatronics, telecommunications, aviation and rocketry, mechanics, amongst other subjects. This guided hands-on learning helps students synthesize a working system, utilize feedback from the real world to validate designs, and learn from failure.

The World CanSat/Rocketry Championship (WCRC) has emerged as a globally recognized international competition where academia teams representing their nations and compete to have their CanSats perform a certain defined mission. Winning this event is considered to be the attainment of a recognized level of competency in the interdisciplinary field of satellite development. Starting from a modest beginning as the International CanSat/Rocketry Competition in Serbia in 2019, the pilot endeavour has grown to a global scale with the participation and cooperation from six founder countries including Serbia, India, Italy, Tunisia, Canada, and Peru. The responsibility of each founder country is to promote, organize and hold the Competition on their continent every year, with the World Finals being scheduled in one of the location.

The competition consists of 3 phases: Phase 1–National CanSat/Rocketry Competition as a qualifier for the Continental CanSat/Rocketry Competition. In this Competition, student teams participate across their own states Nations. If the State does not have a National Competition, then all student teams can directly



participate in the Phase 2 Competition; The Phase 2-Continental CanSat/Rocketry Competition as a qualifier for the World Finals; and Phase-3 is the World Finals CanSat/Rocketry Competition.

Due to the pandemic during the year 2021-22, all National and Continental competitions have been cancelled and all teams eligible to participate directly the World Finals. For the period 2022-23, the Championship will be realized through all the phases as envisaged.

Eligibility Criteria

For a student team to be accepted in the international competition, they need to fulfill the condition that the team has 3-5 members. It is essential that all the team members are students enrolled full-time in a university or a similar higher educational institution. The team could have a Mentor/Professor to guide the team.

WCRC World Finals 2021-22 will be held at the same time with the European Championship in Rocket Modeling. Serbia has traditionally hosted International Rocket Modeling Competitions, European and World Championships. It can be stated, as an interesting historical fact, that Serbia has organized the first World Championship in Rocket Modeling nearly 50 years ago.

The highlight of the WCRC World Finals 2021/22 will be the launch campaign, taking place from 25-29 September 2022. The launch campaign will be realized at 2 places in Serbia. The first place is the launch spot Aradac, located in the Zrenjanin municipality and the second place is in the city of Novi Sad.

All the teams participating in the WCRCWF2021/22 launch campaign will have to carry out technical work on their CanSats, applying the procedures used in the typical lifecycle of a real Space project, which include;

- Selection of mission objectives
- Definition of technical requirements necessary to achieve these objectives
- Design of hardware and software
- Design of ground telecommunication system
- Integration and testing of the CanSat before the launch campaign starts

A Jury of experts will be nominated by the WCRC Consortium to evaluate the teams and their work. The jury will consider the methodology used by the teams to obtain the results, the reliability and robustness of the CanSat, its visual appearance, and its performance. Innovative aspects of the project will be judged for example the tools selected and the hardware/ software used.

Upcoming Global CanSat Competitions

CANSAT India 2022-23

The Indian National-Space Promotion & Authorization Center (IN-SPACe), in collaboration with the Astronautical Society of India (ASI) and other space associations is organizing a national-level university student satellite competition in order to encourage and give undergraduate students of India the opportunity to learn and design satellite systems.

The competition gives students the opportunity to create their own nano/microsatellite leveraging the "design-develop-launch" theme. The participating teams will be put through the paces of the development cycle of a CanSat, that

is a functional simulation of a satellite in the footprint of a 350-ml beverage can.

The organizers would be providing the launcher, which would carry the satellite to a height of roughly 1.5 kilometres. A team of experts will evaluate the CanSat's functionality in accordance with predetermined milestones.

The goal of the mission is to replicate the development of a typical satellite including the power sub systems, instrumentation, telemetry & telecommand, and payloads. The teams' performance would be evaluated based on schedules, the use of Make-in-India components and NavIC signal, design review presentations, and the following parameters of the demonstration flight.

- Design of hardware and software
- Design of ground station/ground telecommunication system
- Integration and testing of the CanSat before the launch campaign starts

https://www.asindia.org/assets/files/Guidelines%20for%20CANSAT.pdf

CanSat United States 2023

The American Astronautical Society (AAS) is organizing an annual student design-build-launch competition for space-related topics.

The next annual competition is open to teams from universities and colleges will be held 8-11 June 2023 at Virginia Tech, Blacksburg, VA. Teams must be able to design and build a space-type system, following the approved competition guide, and then compete against each at the end of two semesters to determine the winners. Rockets will be provided.

The mission is to simulate the landing sequence of a planetary probe.

https://www.cansatcompetition.com

European CanSat Competition 2023

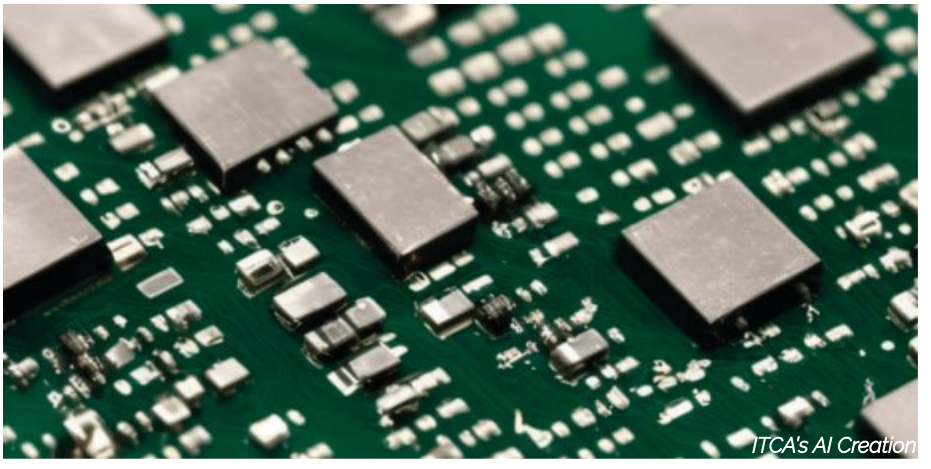
The European Space Agency (ESA) endorses and supports a range of CanSat activities across its Member and Associate States, all leading to a final European event – the European CanSat Competition. The CanSat project, aimed at secondary school students, mainly addresses curricular subjects such as technology, physics, and programming.

Students from the other European nations are invited to participate in their CanSat competitions. ESA is organizing the European CanSat Competition for students from ESA Member States, Canada, Latvia, Lithuania, Slovakia, and Slovenia as they do not have a national competition yet.

The winning team from each of the national competitions, along with the teams selected directly by ESA, will participate in the European launch campaign, which will take place from| 26 - 30 June 2023.

https://www.esa.int/Education/CanSat/2023_European_CanSat_Competition

Reshaping Critical Aerospace Semiconductor Supply Chain


ITCA's AI Creation

The global satellite manufacturing market was valued at roughly US$26 billion in 2021 and is anticipated to expand rapidly over the next decade, fuelled by the launch of approximately 1700 new satellites per year, up from the current annual average of 350. Satellites and spacecraft require a large quantity of semiconductor electrical components to enable the development of numerous new uses of space technology.

Covid-imposed raw material scarcity and production shutdowns, rising demand for commercial work-from-home devices like laptops, tablets, and routers, and the continued expansion of the space market have resulted in supply chain challenges including component shortages, extended lead times and increased prices for space missions globally.

Recap the Semiconductor Industry

The sector is responsible for US$450 billion in direct annual revenues. This number still pales in comparison to the value that this industry generates for the global economy, as semiconductors are the backbone of digitization.

While the semiconductor industry has previously faced shortages, the crisis brought on by the pandemic in March 2020 was very severe, especially in Europe and the USA. The demand for semiconductors decreased, and orders were canceled during the pandemic. Coupled with this, Asian manufacturing slowed down, and many manufacturing facilities were shut down due to repeated lockdowns. Semiconductor manufacturing units across the globe were compelled to operate at a significantly reduced capacity due to weak demand and COVID safety concerns that resulted in low utilization rates.

The Ecosystem

Dr Satya Gupta, President of the VLSI Society of India and Advisor to the India Electronics and Semiconductor Association (IESA) explains, *"The semiconductor supply chain is a complex ecosystem involving companies from various countries and continents for raw material, equipment, wafer manufacturing, packaging, fabless companies, distributors, and finally electronic products as customers. Any slight disturbance in any portion of this complicated supply chain causes a ripple effect that impacts everyone."*

Geopolitical Power Dynamics

The chip industry has been caught in the power struggle between the regional behemoths, USA and China who are competing for technological supremacy. Neither of the two nations is capable of sustaining an entire supply chain on its own. USA currently holds a significant advantage over China in terms of industrial capability. This is especially evident in fields like intellectual property, chip design, manufacturing, and non-wafer materials.

China, on the other hand, is the most important supplier of manufacturing-related raw materials such as silicon. Both the United States and China depend heavily on Taiwan, South Korea, and Japan in industries such as contract manufacturing. Through export regulations, both USA and China are projecting their power to influence and direct the semiconductor industry. Taiwan is the most contentious issue at hand. As a result of escalating U S pressure, the Taiwanese manufacturer TSMC has ceased providing semiconductors to Huawei. These geopolitical conflicts have the potential to further destabilize weak supply chains, as Taiwan is home to a large number of contract manufacturers with a 65 percent market share.

Russia-Ukraine War

The ongoing war in Ukraine is playing truant, and slowing down the rebound we are seeing in the satellite industry too.

Russia is the largest producer of palladium when it comes to materials and components. Palladium is necessary for memory and sensor chip production. It also required manufacturing in a number of other essential raw materials for computer circuits, including scandium, a rare–earth metal., Ukraine is the foremost exporter of neon gas. It is a highly purified gas that is used to produce chips by etching silicon wafers with circuit patterns. With disruption in the supplies of critical raw materials, the semiconductor industry is unable

to meet the existing demand on time.

Space Electronics

Companies that manufacture launch vehicles and satellites are encountering prolonged lead times and rising component costs. Before signing a contract to ensure the on-time delivery of their space electronics, a number of clients are seeking assurance from semiconductor manufacturers that they can produce the necessary components as per the stipulated schedule.

Several makers of space-grade semiconductors with their own foundries have experienced difficulties in obtaining "raw materials" such as ceramic packages and lead frames. The COVID-enforced lockdowns have hampered their availability, resulting in extended lead times for several space-qualified integrated circuits. Some manufacturers are required to adhere to the AS9100 quality standard, which includes audits for on-time delivery. Distributors of space-grade components used to maintain inventory, but this practice is waning, and they too are experiencing longer lead times and higher pricing.

There has been a dramatic trend in recent years toward the use of small satellites rather than traditional larger ones. In addition, the market has witnessed a shift from the use of tiny satellites for one-time missions to their regular incorporation into satellite constellations. In tandem with the rapid expansion of SmallSat constellations for applications such as Earth observation, remote sensing, and space-based broadband services, the demand for radiation-resistant electronic components has expanded substantially.

There are methods for dealing with space radiation, including redundant subsystems, selective shielding, and up-screening commercially available off-the-shelf (COTS) electronics for improved reliability. Several programs are currently underway to produce advanced radiation-hardened electronics with enhanced capability to shield space perturbations at low cost.

These programs are expected to expand and cater to the launch of upcoming mega-constellations. Onboard computers, microprocessors and microcontrollers, power sources, memory (solid-state recorder), field-programmable gate array, transmitter, and receiver (antennas), application-specific integrated circuits, and sensors are examples of radiation-resistant electronics currently in need.

Industry Forecast

Despite the fact that some industry analysts anticipate the shortage will persist until 2023, there is a growing consensus that the end is near, as the chip industry has increased capital spending and plants that have been under development for years are finally coming up. The recent American CHIPS and Science Act of 2022 is great move that aims to increase investments in semiconductor manufacturing capacity to meet future demands. This crucial law could potentially alleviate the problems resulting from geopolitical conflicts and help stabilize semiconductor supplies for space programmes. Furthermore, it seeks to jump-start R&D and commercialize cutting-edge innovations such as quantum computing, artificial intelligence, renewable energy, and nanotechnology.

Indian Semiconductor Initiatives

The Government of India is focused on building the comprehensive semiconductor ecosystem and ensuring that, it catalyses India's rapidly expanding electronic manufacturing and innovation ecosystem. This vision of Atmanirbhar Bharat in electronics and semiconductors was given further momentum by the Union Cabinet approving the "Semicon India" programme with a total outlay of INR 76,000 crore for the development of semiconductor and display manufacturing ecosystem in our country. The programme aims to provide financial support to companies investing in semiconductors, display manufacturing and design ecosystem. This will pave the way for India's growing presence in the global electronics value chains.

India Semiconductor Mission (ISM) has been setup to formulate and drive India's long-term strategies for developing semiconductors and chip design. The Vision of ISM is to build a vibrant semiconductor and display design & innovation ecosystem to enable India's emergence as a global hub for electronics manufacturing and design. It will enable a multi-fold growth of Indian semiconductor design industry by providing requisite support in the form of Electronic Design Automation (EDA) tools, foundry services and other suitable mechanisms for early-stage start-ups. It will also promote and facilitate indigenous Intellectual Property (IP) generation and encourage, enable, and incentivize Transfer of Technologies (ToT). ISM will also enable collaborations and partnership programs with national and international agencies, industries and institutions for catalyzing collaborative research, commercialization, and skill development.

Taking cue from the initiatives launched at the national level, the Government of Karnataka has signed a memorandum of understanding (MoU) with Israel-based International Semiconductor Consortium (ISMC) to invest 22,900 crores ($3 billion) in the state to set up the country's first and largest semiconductor chip-making plant. The investment is aimed at creating a 65 nm Analog Semiconductor Fabrication plant. Leading Indian conglomerate Reliance Industries and software services giant HCL are reported to be planning to invest in the semiconductor consortium through subsidiaries.

Tamil Nadu is in talks with the Singapore-based IGSS Ventures to setup a high-tech semiconductor park in the state. The Semiconductor fabrication plant is expected to produce wafers ranging from 28 nm, 45 nm and 65 nm, and will create an industry ecosystem infrastructure that hosts semiconductor circuit designers, material suppliers, equipment suppliers, and outsourced semiconductor assembly and test (OSATs) players.

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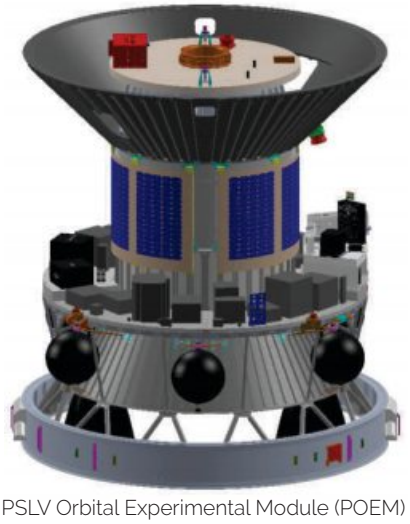
Indian Space Sector Forging Ahead...

The Indian Space Research Organisation (ISRO) conducted the second launch of the year as the PSLV-C53 mission lifted-off from the Satish Dhawan Space Centre in Sriharikota on 30 June 2022. The PSLV-C53 mission deployed the three satellites in LEO. This was the second dedicated commercial mission of NewSpace India Limited (NSIL). It was designed to orbit the Singaporean Earth Observation satellite (DS-EO satellite) along with two other co-passenger satellites from Singapore, a 155 kg satellite NeuSAR, and SCOOB-I of Nanyang Technological University (NTU).

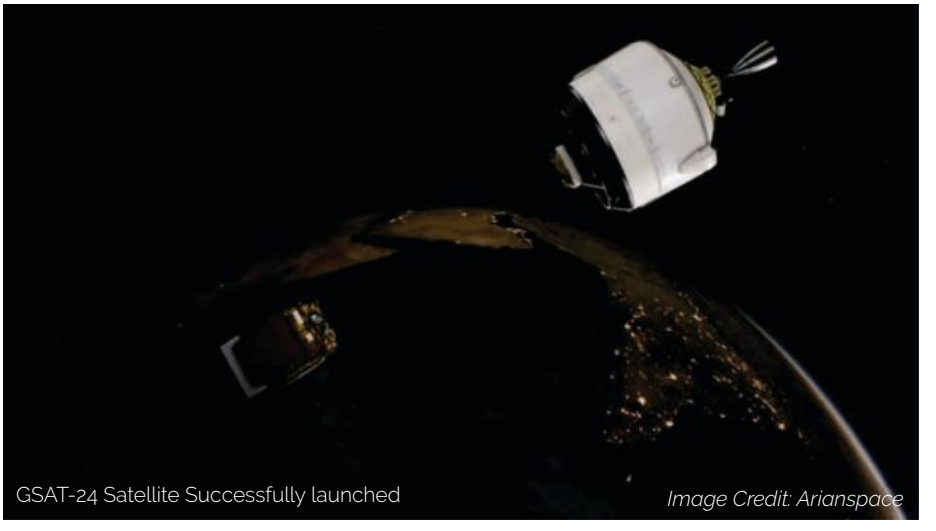
The DS-EO satellite carried an Electro-Optic, multi-spectral payload with 0.5 m resolution imaging capability. The SCOOB-I is the first satellite in the Student Satellite Series (S3-I), a hands-on student training program from the Satellite Research Centre (SaRC) at Singapore's NTU School of Electrical and Electronic Engineering.

In addition to successfully launching three satellites for Singapore, the ISRO completed the formal deployment of the PSLV Orbital Experimental Module (POEM). The



PSLV Orbital Experimental Module (POEM)

Image Credit: ISRO



GSAT-24 Satellite Successfully launched

Image Credit: Arianspace

PSLV POEM will perform in-orbit scientific studies using the spent PS4 stage as a platform. The PS4 stage would orbit the earth as a stabilized platform. Attitude stabilization is achieved using a dedicated NGC system. POEM would derive the power from the solar panels mounted around the PS4 tank and a Li-Ion battery. It navigates using four sun sensors, a magnetometer, gyros and NavIC. It carries dedicated control thrusters using helium gas storage and is enabled with the telecommand feature. POEM carries six payloads including two from Indian Space start-ups M/s Digantara and M/s Dhruva Space, facilitated through the Indian National Space Promotion and Authorization Center (IN-SPACe) and NSIL.

Earlier, NSIL successfully launched GSAT-24 on 23 June 2022, leasing the entire satellite's capacity to Direct-to-Home (DTH) service provider Tata Play.

GSAT-24, a 24-Ku band communication satellite weighing over 4 tonnes and designed by ISRO for NSIL, provides pan-India coverage for DTH application requirements. It has a 15-year mission life and is configured on ISRO's proven I-3k Bus. The satellite was launched from the Guiana Space Centre, Europe's spaceport in Kourou, on Ariane-V VA257.

"The successful mission of GSAT-24 is a major step forward for NSIL in commercially meeting the DTH communication needs of the country using indigenously built satellite solutions from ISRO," said Secretary, Department of Space and ISRO Chairman, Dr S Somanath.

India's Private Space Sector: Fuelling Activity in 2022

Principal Scientific Advisor, Government of India Dr Ajay Kumar Sood informed the press that the government was finalising the Space Policy 2022 and would unveil it soon. *"We have not tapped the full potential of this sector. In 2022, the space sector is witnessing what the information technology sector experienced in the 1990s. We will have our own SpaceX in the next two years,"* he said.

As a part of the India International Centre's diamond jubilee celebration, ISRO conducted a seven-day expo, with focus on industry-academia engagement, panel discussions on

prospects and avenues for new space in India. The week-long event was sponsored by the Satcom India Association (SIA) and the Indian Space Association (ISpA).

Dr S Somanath, Dr Shailesh Nayak, Director, National Institute of Advanced Studies; Dr Sachin Chaturvedi, Director, Research and Information System for Developing Countries (RIS); Shri Shekhar Datt, former Governor, Chhattisgarh; Shri Suneel Niraniyan, DDG-DOT; Shri Sanjay Kumar, Founder & CEO, Geospatial World participated in the deliberations. The emphasis of the discussions was on the synergy between government, industry, and academia to address the myriad opportunities presented through the various policy initiative ushered by the Government of India.

H E Ms Daniela-Mariana Sezonov Tane, Ambassador of Romania to India, Nepal and Bangladesh visited ISRO Headquarters on 28 July 2022 and had a brief meeting with the ISRO Chairman. Space cooperation between the space agencies and initiating possible collaboration in the area of Space Situational Awareness was discussed.

"Private companies in India will finally be allowed to launch their own commercial space projects by this year-end with the government set to soon announce the new space policy," said Dr Pawan Goenka, Chairman, IN-SPACe. Speaking in an interview at the inauguration of the headquarters of ISpA, Dr Goenka said the first batch of five Polar Satellite Launch Vehicles (PSLVs) built by a consortium of Hindustan Aeronautics Ltd (HAL) and Larsen and Toubro Ltd (L&T) will be used solely by ISRO. This would be the first instance wherein an entire rocket would be built outside the Government space agency.

The new space policy is also expected to allow Indian private firms work alongside government entities for commercial space missions. ISRO will mostly be tasked with the scientific R&D work.

Union Minister of State (MoS) for Science and Technology Dr Jitendra Singh speaking after inaugurating the "ISRO System for Safe and Sustainable Operation" (IS4OM) on 11 July 2022 said that around 60 start-ups had registered with ISRO since the 'unlocking' of the Indian space sector. The start-ups' proposals vary from nanosatellites, launch vehicles, ground systems, and research, among others.

Dr Singh also said, *"IS4OM facility will aid India in achieving its SSA (Space Situational Awareness) goals by providing comprehensive and timely information of the Space environment to users. This multi-domain awareness platform will bring prompt, accurate, and efficient information on on-orbit collision, fragmentation, atmospheric re-entry risk, space-based strategic information, hazardous asteroids, and space weather forecast."* He emphasized that the facility is conceived with a holistic approach toward ensuring safety and sustainability while reaping the benefits of sustainable utilization of outer space for national development.

The Department for Promotion of Industry and Internal Trade (DPIIT), Government of India, along with ISRO launched the NavIC Grand Challenge for Indian start-ups. The challenge involves the development of indigenous NavIC-enabled drones to capture data on damage caused to farms, processing of the data, and make it available for use for commercial purposes. ISRO experts would provide technical guidance to the short-listed start-ups.

ISRO's 'Intelligent' Satellites

ISRO is developing "intelligent" geostationary communication satellites that can be re-configured by changing frequencies and bandwidth as per the demand profile from customers.

ISRO would do a technology demonstration internally, it would encourage the private sector to build and market such services.

ISRO also looking at certain intelligent Geosynchronous satellites (GSAT) in the years to come which will be able to reconfigure, and remodel based on the demand. This is already a subject of discussion on design front.

- ISRO Sources

Typical Review Methodology
for Successful CubeSat Development

The lifespan of a typical CubeSat development project is characterized as a set of phases, including "Formulation," "Approval," and "Implementation." Each of these phases consists of a sequence of functions and a workflow to derive the deliverable that are required for the completion of that step. It is possible to specify a review as the validating event for the phase in question, and its output is a revised mission baseline.

The following sections emphasize the set of reviews that can be structured and modified by the CubeSat development team in conjunction with the stakeholders to suit the objectives of the project and ensure that the mission is successful. This series of reviews is highlighted in the following parts.

Mission Concept Review (MCR)

Objectives of MCR

- The goals of the mission have been precisely outlined and articulated; they are also explicit and internally consistent.
- The basic set of requirements does a good job of providing a system that will successfully accomplish the goals of the mission.
- It is possible to accomplish the goal. It has been determined that there is a solution that is doable from a technological standpoint. A approximate cost estimate falls within a price range that is considered acceptable.
- The criteria for evaluating concepts that will be utilized in the selection of candidate systems have been defined and ranked in order of importance.
- It is now abundantly evident how important it is to complete this assignment.
- The projections for both the cost and the timetable are credible.
- A technical search was carried out in order to locate assets or products already in existence that might be able to fulfil the mission or sections of the mission.
- Technical planning has been completed to the extent necessary to go on to the next step.

System Requirements Review (SRR) and/or Mission Definition Review (MDR)

In the SRR and/or MDR, overall requirements that have been developed for the system, as well as the preliminary programme or project plan, are evaluated, and it is ensured that both the requirements and the concept that has been picked will be able to fulfil the mission.

SRR and/or MDR is typically carried out during the idea development phase after the completion of the concept studies phase, following the baseline of the Systems Engineering Management Plan (SEMP), and prior to the preliminary design phase and System Definition Review. These phases are typically preceded by System Definition Review (SDR).

Objectives of SRR/ MDR

- The overall concept is reasonable, feasible, comprehensive, mission-responsive, and consistent with system requirements and resources (cost, schedule, mass power, etc.).
- The project has a sound process for distributing and controlling requirements at all levels and a plan to complete the definition activity on time.
- Top-level mission and science requirements are defined, as are external and internal interfaces.
- Subsystems have been given requirements and key driving requirements.
- There are requirements-compliant system and subsystem design and operational concepts.
- The mission's requirements, design approaches, and conceptual design are budget-friendly.
- Preliminary approaches for validating subsystem requirements have been determined.
- Significant risks have been identified and mitigated.

System Definition Review (SDR)

The SDR evaluates the proposed architecture and design of the system, as well as the flow down to each and every functional component of the system. During the early stages of the preliminary design phase, prior to the Preliminary Design Review, SDR is carried out.

Objectives of SDR

- The proposed conceptual design is based on the defined system requirements, which include mission success criteria and any restrictions put in place by the sponsor.
- All technical requirements have been met, and the flow down to subsystems is sufficient. The design definition is adequate to support preliminary parametric and bottom-up cost estimation.
- Credible and responsive to the requirements that were outlined, the technical approach meets all of the criteria.
- As needed, technical plans have been updated.
- All of the trade-offs have been finished, and the ones that have been planned for phase B will

adequately address the requirements

- Significant risks to development, mission, and safety have been identified, and there is both a risk management process and resources available to manage these risks.
- There is adequate planning for the development of any enabling new technology.

Preliminary Design Review (PDR)

The Preliminary Design Review (PDR) creates the basis for moving forward with detailed design by demonstrating that the preliminary design satisfies all of the system requirements while maintaining an acceptable level of risk and remaining within the restrictions imposed by cost and schedule. It will demonstrate that the appropriate design option was chosen, interfaces will be shown to have been defined, and verification procedures will have been provided. The PDR is the final review that takes place during the formulation phase and happens close to the end of the preliminary design phase.

Objectives of PDR

- There is agreement on the top-level requirements, such as mission success criteria, technical performance measures (TPMs), and any constraints imposed by the sponsor, and that these requirements are finalized, clearly stated, and in line with the preliminary design.
- The flow down of requirements that can be checked is complete and correct, or if it isn't, there is a good plan for getting open items taken care of in a timely manner. Mission goals and objectives can be linked to requirements.
- The preliminary design should be able to meet the needs with a level of risk that is acceptable.
- The technical interfaces are defined in a way that fits with the overall level of technical maturity and shows an acceptable level of risk.
- Appropriate technical interfaces are in line with the technical maturity as a whole and offer an acceptable level of risk.
- There are enough technical margins when it comes to measuring technical performance (TPMs)
- Any new technology that is needed has been developed to the point where it is ready, or there are backup options that are supported enough to make them a good choice.
- The project's risks are known, and there are plans, a process, and resources to handle them well.
- Safety and mission assurance (S&MA) have been taken into account in preliminary designs, and any applicable S&MA products (i.e., hazard analysis and failure modes and effects analysis) have been examined.
- The operational concept is technically sound, it takes into account human factors when they are important, and the requirements for how it should be done flow down.

Critical Design Review (CDR)

The CDR is intended to demonstrate that the technical effort to accomplish the flight and ground system development and mission operations within the budgets. and constraints is on track, and that the design is mature enough to warrant moving forward with full-scale fabrication, assembly, integration, and testing. CDR occurs prior to manufacture, assembly, and testing, and often just prior to the completion of the final design.

Objectives of CDR

- It is anticipated that the detailed design will meet the requirements with enough margins and an acceptable level of risk.
- The interface control papers are mature enough to proceed with fabrication, assembly, integration, and testing, and there are preparations in place to manage any outstanding items.
- There is high confidence in the product baseline, and sufficient documentation exists or will exist in a timely way to allow manufacture, assembly, integration, and testing to commence.
- The requirements and plans for product verification and product validation are complete.
- The approach to testing is exhaustive, and the planning for system assembly, integration, testing, launch site operations, and mission operations is adequate to proceed to the next phase.
- There are sufficient technical and programmatic margins and resources to complete the development within the restrictions of cost, time, and risk.
- Risks to the accomplishment of the mission are comprehended, and there are plans and resources to successfully manage them.
- Safety and mission assurance, i.e., safety, reliability, maintainability, quality, and Electrical, Electronic and Electro-mechanical (EEE) components have been sufficiently addressed in system and operational designs, and any applicable S&MA products (i.e., hazard analysis and failure modes and effects analysis) have been authorized.

Manufacturing Readiness Review (MRR)

A Manufacturing Readiness Review (MRR) evaluates a project's design and process to determine how effectively it can manufacture the required number of units. It ensures that the production plans, fabrication, assembly, and integration enabling items, and personnel are in place and prepared for production to commence. Moreover, it assures that the production is prepared to commence.

Objectives of MRR

- The design has the required approvals.
- Final production configuration satisfies all the system's needs.
- There are sufficient measures in place to support production.
- Design-for-manufacturing factors ensure production and assembly

are simple and efficient.
- Risks have been discovered, appraised credibly, and categorised, and mitigation strategies have been outlined.
- The bill of materials has been analysed and essential components have been identified.
- The delivery timelines have been confirmed.
- Suitable alternate sources for resources have been identified.
- Adequate spares have been budgeted for and planned for.
- The required facilities and equipment are adequate for final product manufacture.
- There are sufficient amounts of the specified special tools and test equipment.
- Processes and techniques of production comply with occupational safety, environmental, and energy conservation legislation and adhere to quality standards.

Test Readiness Review (TRR)

Through the use of a readiness check, a TRR can ensure that the test article (hardware or software), test facility, support staff, and test procedures are all ready for testing, as well as ready for the collection of data, reduction of data, and management of data. A TRR will be carried out in advance of the commencement of the verification testing.

Objectives of TRR

- The appropriate test plans for the system that is being evaluated have been finished and authorized.
- successfully completed the necessary steps for identifying and coordinating the relevant test resources.
- The findings of previous component, subsystem, and system testing provide a firm foundation upon which to build for future tests that are planned.
- The leadership of the programme or competency will determine and accept the risk level as it becomes necessary.
- Create a strategy for documenting any takeaways you may have gained from the testing programme.
- The objectives of the testing have been outlined in detail and recorded, and after going through all of the test plans, as well as the processes, environment, and test item configurations, it is reasonable to anticipate that the objectives will be accomplished.
- The test cases have been examined and analyzed to determine the expected results, and those results have been found to be in agreement with the test plans and goals.
- Test staff have been given training on the operations of the test as well as the safety protocols involved.

Systems Acceptance Review (SAR)

The objective of the SAR is to verify that the particular end item is complete with regard to the intended maturity level and to evaluate whether or not it complies with the expectations of the stakeholders. During the SAR, the system, its final products and documentation, as well as test data and analysis that assist verification, are all investigated. Additionally, it guarantees that the system has reached the level of technical maturity necessary to permit its shipment to the operational facility or launch site that has been specified. The SAR occurs toward the end of the phase that encompasses fabrication, assembly, integration, and testing.

Objectives of SAR

- All necessary tests and analyses have been completed, and the results indicate that the system will function properly in the anticipated operational environment.
- The risks are well understood and manageable.
- The system meets the acceptance criteria that were specified.
- Shipping, handling, checkout, and operational plans and procedures have been completed and are now ready for use.
- The technical data package has been completed, and its contents accurately represent the delivered system.
- All relevant lessons learned for the improvement of the organization and system operation are saved here.

Flight Readiness Review (FRR)

The Flight Readiness Review (FRR) investigates the experiments, demonstrations, analyses, and audits that evaluate whether or not the system is prepared for a flight or launch that is both safe and successful, as well as for continuing flight operations. In addition to this, it guarantees that all of the flight and ground gear, software, personnel, and procedures are prepared for operational use. The FRR is not performed until after the system has been prepared for flight configuration.

Objectives of FRR

- The launch vehicle is now prepared for lift-off.
- The equipment is in good shape for a flight that won't endanger anyone and has a good chance of accomplishing its objective.
- The pieces of the flight and ground software necessary to support flight and flight operations are ready.
- The interfaces are tested, and it is determined that they are functioning.
- Open items and waivers have been evaluated, and it has been determined that they can be accepted.
- The flight and recovery environment parameters are not outside of the acceptable range.
- All of the open concerns regarding safety and the mission's danger have been resolved.

Operational Readiness Review (ORR)

ORR conducts an analysis of the actual system characteristics as well as the procedures that are used in the operation of the system or product in order to ensure that all system and support (flight and ground) hardware, software, personnel, procedures, and user documentation accurately reflect the system in its deployed state. This is done in order to ensure that all hardware and software accurately reflect the system in its deployed state.

Objectives of ORR

- It has been determined that the system, along with any goods that make it possible, is prepared to be moved into an operational position.
- The entirety of the useful lessons learnt for the operation of systems and the enhancement of the organization have been captured.
- All deficiencies and irregularities have been plugged up.
- In order to support operations, the necessary hardware, software, staff, and processes have been implemented.

Decommissioning Review (DR)

Confirming the decision to terminate or decommission the system, as well as evaluating whether or not enough preparations have been made for the secure decommissioning and disposal of system assets, are the goals of the DR. The DR is often carried out toward the latter stages of ordinary mission operations, after the completion of all specified mission goals. It is possible for it to be brought forward in the event that an unanticipated incident gives rise to the necessity to prematurely terminate the mission, or it is possible for it to be brought forward in the event that the operational life of the mission is extended to permit additional investigations.

Objectives of DR

- The reasons for disposal of decommissioned equipment are documented.
- The decommissioning and disposal plan is complete, has been approved by appropriate management, and is in accordance with all applicable Agency safety, environmental, and health regulations. All potential scenarios, including contingencies, have complete and approved operations plans. All necessary support systems are on hand.
- All personnel have received adequate training in both nominal and contingency procedures.
- Hazards to safety, health, and the environment have been identified. The controls have been validated.
- The risks of disposal have been identified and adequately mitigated. The required management has accepted residual risks.
- If hardware must be recovered from space:
    - Plans for return site activities have been defined and approved.
    - If necessary, required facilities are available and meet requirements, including those for contamination control.
    - Transportation strategies have been developed and approved. There are shipping containers and handling equipment available, as well as contamination and environmental control and monitoring devices.
- Plans have been defined and approved for the disposition of mission-owned assets (hardware, software, facilities, etc.).
- Plans for archiving and analyzing mission data have been defined and approved. The plans for their implementation have been finalized. Plans for capturing and disseminating relevant lessons learned throughout the project life cycle have been defined and approved. Adequate resources (schedule, budget, and personnel) have been identified and are available to complete all decommissioning, disposal, and disposition activities successfully..

Technical Peer Reviews

Peer reviews help assure product and process quality. Peer reviews are concentrated, in-depth technical reviews that support product design and development, including crucial documentation or data packages. Peer review adds value and reduces risk through expert knowledge, infusion, approach confirmation, problem spotting, and product enhancement suggestions.

TPR results are a vital part of the review process. These reviews document and report outcomes and issues to the next higher element level.

Peer reviewers should be chosen from outside the project based on their competence and experience. Peer reviewers should solely care about product quality and technical integrity. Simple, informal peer appraisals are best. They should check the documentation and reduce viewgraphs. Round-table presentations are favoured over stand-up ones. Peer reviews should be technically complete.

The review team needs enough technical knowledge to understand the risks. Peer review consistency requires rules. An action report must be distributed after the review.

Outsourced systems engineering projects must include peer reviews

Teamwork and collaboration are the essence of systems engineering practices. Reviews help in ensuring that the project elements are tested as modules, dedicating attention to the interfaces. By calling out the assumptions made by the design team, the project team can leverage the reviews to identify hidden or unexposed problems, well before the launch and deployment of the satellites.

Reviews are extremely helpful in ensuring that the technical direction for the project is appropriate, and the envisaged technical goals are being achieved. Potential risks and sub-optimal design issues are trapped early in the project lifecycle with adequate opportunity for recommending improvements and appropriate corrective and preventive actions.

These reviews are backed up with comprehensive documentation, meticulous monitoring and follow-up of the action items emanating from the reviews. These reviews also help in arriving at critical technical decisions on subsystem performance in the context of the mission objectives and specifications of the various subsystems.

The review process is extremely useful in ensuring that the design, project execution and monitoring methodologies deployed result in delivering a functional and reliable satellite, meeting the mission goals with a level of quality acceptable to all the stakeholders.

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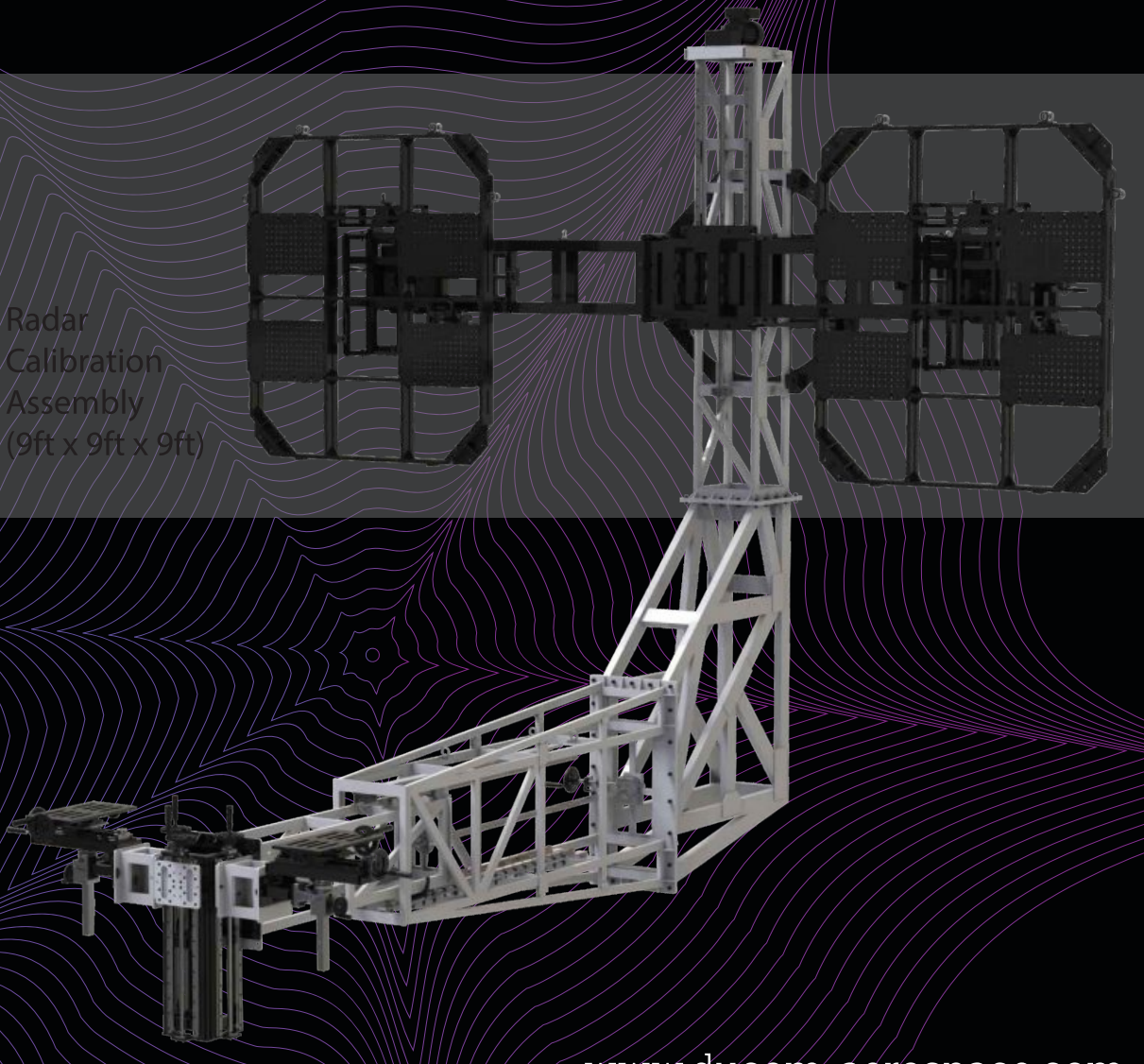

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Invited Article

NTU Singapore SCOOB-I
Success and Lessons Learnt

Mr Lim Wee Seng
Executive Director
Satellite Research Centre
Nanyang Technological
University, Singapore

A satellite (named SCOOB-I, where I (one) stands for it being the first in a series of many to come) that had been built by a team of students from Nanyang Technological University in Singapore, was launched by the Indian Space Research Organization (ISRO) on Thursday 30 June 2022 around 6:00 pm India Standard Time. This satellite was built by several, mostly undergraduate, students, including visiting students from the Indian Institute of Space Science and Technology (IIST). SCOOB-I has found a home at a Low-Earth Orbit (LEO) altitude of 570 kilometers above the ground; being in an almost-equatorial 10-degree inclination orbit it will see a new sunrise about every 96 minutes.

This satellite has onboard two instrumental payloads: the main payload is a multispectral sun sensor and the secondary one is an RGB camera. The RGB camera will take pictures, which can be pictures of a place on Earth or wherever we point the satellite to. The multispectral sun sensor has the scientific goal of helping characterize the emissions from the sun by looking at the spectra of the electromagnetic waves emitted by the sun. Once the data has been collected it is sent to a ground station on Earth. The transmission is done using an Ultra High Frequency (UHF) transceiver at 437.65 MHz.

In terms of structure and form factor, the satellite is a 3-unit CubeSat, measuring about 10 cm by 10 cm by 32 cm with its structure primarily made of aluminium metal. Along two of its axes, SCOOB-I has bundles of rods of a material called HyMu80. This special nickel-iron-molybdeumalloy serves to damp the rotational energy of the spacecraft thanks to a phenomenon called magnetic hysteresis. There are also permanent magnets onboard with which the satellite will align with the magnetic field lines of the Earth's ambient magnetic field.

For electrical energy, it has solar panels on the four faces parallel to the long axis, generating over 7 watts when in the Sun (on the dayside). Some of the solar energy is then stored in a 20.4 Wh lithium polymer battery whose energy is used when SCOOB-I is on the nightside.

Student Involvement

One of the goals of this student-run satellite program at NTU Singapore is to nurture space talent needed for Singapore's burgeoning space ecosystem. This program was launched in the summer of 2018 by a group of PhD students and NTU's Satellite Research Center (SaRC) experts with the support of Assistant Professor Amal Chandran (Director of Space Technology at NTU). Students began to take advantage of this opportunity through Final year projects (FYP), full-time internships, part-time internships, and volunteer work. A total of 48 students have taken part since 2018 and worked on various subsystems of the satellites. Their tasks were managed by PhD students and SaRC experts.

(Left) Christopher Luwanga, a student working on the SCOOB-I satellite with his fellow researcher Yeoh Jun Kai (right) at NTU Singapore

(Left) Tamas Szecsennyi, a student working on the SCOOB-I satellite with his fellow researcher Isaac Wong Kang Zhong (right) at NTU Singapore

Running a student-run satellite program at a university is no easy task. The main challenges faced by the group were student unavailability and continuity of work. As students graduate each year, the group experienced delays in assignments as the expert group needed time to train a new group of students on subsystems. To mitigate these issues we relied on two things: great documentation and clear source code commenting. For each of the processes we documented as much as possible, using layman terms where possible, so that someone new to the team and satellite projects can quickly get up to speed through looking at what we had done. We encouraged clear, detailed commenting of source code so that future programmers would much more easily pick up where others had left off. Additionally we opted for the least convoluted implementations so that future debuggers would be able to track down issues.

General Lessons

Satellites like these can have many, many uses. A presently ubiquitous and well-known use for satellites is for broadcasting TV signals to homes. But there are new and exciting applications. "We can, for example, have a set of 5G antennas on the satellite so that it acts as a base or relay station for a 5G mobile cellular network. A collection of such satellites could help provide cheap broadband internet connectivity

to millions of people without much investment on the ground," said Christopher Luwanga, a Malawian test engineer on the project.

The process of building this satellite is similar to that of building other spacecraft, such as those going to the moon or to another planet. When students get this hands-on experience in building a satellite, they can deploy their skills on ever more complex projects.

The most important thing is to organize the existing skills into great teams. A key team member of any space mission is a systems engineer. Kashyapa Bramha Naren Athreyas, who is the systems engineer says, "A systems engineer has to have a broad understanding, knowing what technical skills are needed, identifying components to use, preparing test plans at the component level as well as system level, and so on. He may not do all these things himself, but he has to know enough of each subsystem to assign the tasks appropriately. In football lingo, a systems engineer is akin to a captain, playing alongside his team members." But there are many roles in satellite projects, including mechanical engineers, electrical and electronic engineers, as well as embedded programmers.

But there is more to a satellite project than the technical engineering or scientific stuff. A project manager—who in the football lingo can perhaps be thought of as a coach—has to coordinate a vast number of tasks, and people, to ensure the project is executed well and on time. Shanmugasundaram Selvadurai, the project manager on this project added, "Planning is extremely important in satellite projects. Since space launches are still rather rare, there is often a small time window that you are targeting for launch. So ordering components on time, ensuring there is ample time to iterate over and test the designs, and including buffer times for the unexpected, are all important aspects of managing a project to meet the deadlines. The other aspect of managing a satellite project is structuring the team so that the members have a great time together. This entails creating room for members to give each other candid feedback since anyone's subpar work affects the whole end product; so we made sure people could assist each other."

1st row (from left): Amitha Saleem, Sanika Birthi, Chang Li, Christopher Luwanga, Yin Min Theint;

2nd row (from left): Luo Ruikang, Liu Haotian, Tamas Szecsenyi, Isaac Wong, NTU Satellite Research Centre Executive Director Lim Wee Seng, Joji John Varghese, student team leader Shanmugasundaram Selvadurai, Lim Sir Yang, Senior Research Engineer Lew Jia Min, Lee Choon Kiat, Yeoh Jun Kai.

Creating a Space Ecosystem in India

Can India create a thriving, economically lucrative space ecosystem? India has the capacity to build even the most complex of spacecraft! Given India's phenomenal software engineering talent pool, coupling that with its developed hardware industry would make for an ecosystem that is unparalleled globally. Universities have a very active role in training the next generation of talent pool. For satellite projects it is very important to blend traditional textbook learning with hands-on hardware development since space projects require specialized skills hard to teach unless laboratory work and actual flight hardware development is involved. In this context, India needs to develop this capability in its universities.

The outlook of the space industry is fairly exciting in general. While one key part of the industry is the engineering—such as that involved in building this spacecraft—there are many other aspects. Indian Companies can provide services in all aspects of the space industry on the global stage.

The small satellite segment of the space industry in particular has numerous opportunities that can be commercially explored. Professor Amal Chandran is the Principal Investigator on this SCOOB-I project, leading the entire team as well as liasing with the many key stakeholders of the project including the launch partners at ISRO and industry collaborators in Singapore.

Prof. Chandran has long believed in the power of small satellites. He sees them as bringing about a real revolution in how satellite projects are carried out. "Small does not mean less useful or of lower quality. Large satellites naturally take very long to build as engineers try all they can to reduce risk of failure, requiring some degree of overengineering—and often cost overruns. There is rarely much room to experiment with new technologies. Small satellites on the other hand can be used to test new technologies, and as in this case, provide excellent training for students," he says.

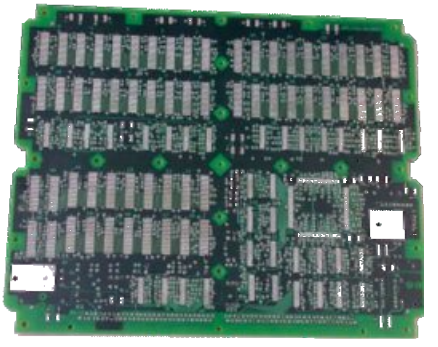
He further adds, "But beyond tech demos and capacity building projects, smallsats are also being developed to implement a variety of commercial solutions such as providing internet connectivity to millions of people as well as for earth observation. Small spacecrafts have also proven to be able to do comparable science to bigger larger more expensive space missions. This shows that smallsats are useful and revolutionary as a technology in their own right."

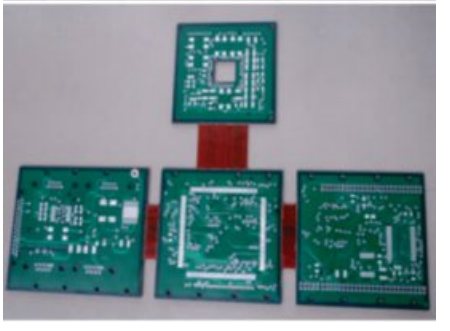
Prof. Chandran believes that India could do well by participating in this smallsat revolution by being a reliable, global space mission partner in all areas of spacecraft development, testing and operations.

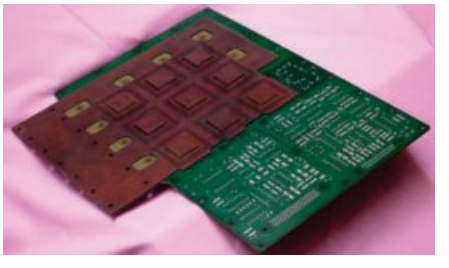
Space Grade PCB Design

G N V Prasad
Advisor, ITCA
Former Deputy Director
ISRO Satellite Center,
URSC/ISRO

With advancements in semiconductor technology, PCB designs have undergone a radical metamorphosis with respect to size and weight and catering to increasing clock speeds on the board. With the ever-increasing use of high VLSI density devices like ASIC and FPGA, PCB designs are becoming increasingly dense and complex. Today's designers need to factor myriad challenges including handling of highly dense interconnections, electrical issues like Signal Integrity (SI), Power Integrity (PI), Electromagnetic Compatibility (EMC), Thermal management, and placement and routing of high pin count/fine-pitch components. Space-grade PCB design and fabrication is a very critical task, and needs careful process adherence. The following sections highlight the elaborate process that needs to be followed so as to ensure that these PCBs successfully endure the hostile space environment.







Introduction

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate. It is also referred to as printed wiring board (PWB). The PCBs are expensive and are highly reliable. They facilitate high volume production of electronic circuits.

Types of PCBs

Single Sided, Double Sided, Multilayer, RIGID Flex, Metal Core and High Density Interconnect (HDI)

User's Specifications

For Fabrication of PCBs following details have to be specified by the user

- Materials; like FR4 also known as glass epoxy, Teflon, RT duriod, polyimide, kapton etc., Most common material used is FR4 type and for RF applications RT duriod and TFG (Teflon) materials are used. For flex circuits polyimide materials are used. All the substrates come in copper cladded for PCB application.
- Impedance controls; this is very critical for high speed switching signals to avoid cross talks and unwanted reflections. It is required to specify the impedance of the traces carrying high speed signal and is achieved by selecting material with proper dielectric, trace width, spacing, dielectric thickness etc.
- Number of Layers: It is required to specify number of layers like single sided or Double sided or multilayer (4, 6 ----and so on)
- Board Thickness; Depending upon the type of classification like mother board or daughter board and also depending upon type of application, the thickness of the PCB is specified. Further users should give details of the components type & style (Leaded or SMDs)
- Copper thickness; depending upon the current requirements for the given circuit thickness of the copper on the PCB is specified. Generally for all signal boards the thickness to be specified will be 35 microns (1 oz) and for power PCBs it will be either 70 microns or 105 microns.
- Whether any blind via or buried via requirements; the user has to specify any bilnd via's or buried via design so that the PCB fabricator has to take care fabrication with special processes.
- Solder mask coating requirement; Solder mask bridging of liquid solder. This bridging of traces has become a serious problem in

recent times. As the pitch of the IC pins has decreased, bridging of the IC pads occur.

- Finish; the user have to specify whether HASL (Hot air Leveling Solder coating), or Gold plating or ENIG (Electroless nickel immersion gold)or hybrid (selective gold plating with HASL combination)

PCB Layout generation

The PCB design and layout forms an integral part of the design of the whole product, and it can be the key to the success of the product meeting its performance requirements in many instances.

PCB technology has progressed significantly in recent years. The design technologies has improved with PCB CAD systems and PCB software to layout the boards better, and also analyze the performance under conditions such as the operation at high frequencies. In addition to this the technology for the manufacture of PCBs has improved enabling far smaller tracks to be used as well as incorporating features such as multilayer boards with blind vias, etc.

PCB Design Equipment

In the early days of PCBs, the design and layout was undertaken manually using tape that was placed onto a translucent film. These PCB designs were normally four times the required size and they were photographically reduced onto a 1:1 film for the PCB production process.

Nowadays the PCB design process has been computerized and there are many PCB CAD systems and PCB software packages that enable the PCB layout and design to be undertaken more efficiently than before. The PCB software varies considerably in price depending upon the complexity. Further top end packages enable many more facilities to be incorporated into the design. Simulations, complex routing, and many more facilities are available.

PCBs for CubeSat

The proposed 1U CubeSat comprises of all the basic subsystems (EPS, COMM, BEACON, OBC, etc) and available size within the chassis is about 80mm X 80mm. In order to accommodate all the components and to efficiently route all the traces, 95% of the PCBs are multi-layer (8-layer MLBs). The solar panel is built on 8-layer PCB, 1-2 layer forming solar Panel and remaining 6 layers are embedded Magnetic torquer. The proposed 1 U CubeSat uses 15 Printed circuit boards. The PCB material used is FR4 grade 370 HR which is a High TG material. For BEACON Antenna PCB we have gone for Rigid-Flex PCB in order to facilitate self-deployment at the time of Satellite orbit Injection.

Design Tool used

The Design Tool used for the Design of PCBs, Antenna Deployment and Structure is Fusion 360. It is the first and only integrated cloud CAD, CAM, CAE, and PCB product development solution for product designers, mechanical engineers, electronics engineers, and machinists. All the Designs have been subjected for Quality checks and DRC (Design Rule Check)

PCB Manufacturing

The PCBs for proposed 1 U CubeSat has been Fabricated at M/s Mircopack Pvt Ltd Bangalore who are the ISRO qualified PCB manufacturers. All PCBs have been made to IPC 6012 CLASS2 / MIL-PRF-55110H standards and have been subjected to stringent Quality Tests.

CanSat Leadership Training Program (CLTP 11)
The Training Program on Space Engineering Education Methods (ENUS)
Tokyo, Japan, 18 - 31 August 2022

Dr S Rohith, Assistant Professor in the Department of Electrical and Computer Engineering, Nagarjuna College of Engineering and Technology (NCET), Participated in Hands-on Training with CanSat, CubeSats, and Class Room Satellites. The OBC and EPS were both created by him in only three days of training. A total of 15 days' worth of online Sessions were completed by him and other participants from across the world before he left Japan.

After 15 days of online sessions, followed by a comprehensive evaluation and screening process, etc., he has been given permission to participate in hands-on training in Japan. All of the criteria have been met by him. Pupils like Dr. Rohith, who are enthusiastic in space exploration, have received training at the ITCA-TSC-UNISEC India & 75 Students' Satellites Mission Project Office. Sponsored by The Association for Overseas Technical Cooperation and Sustainable Partnerships (AOTS), Tokyo; Dr Rohith was the only person from India selected for such a coveted Space Engineering Training Program.

SARsatX

SAR Constellation for the Benefit of Agriculture

Mr Ahmed Alzubair
Co-Founder
SARsat
Saudi Arabia

SARsatX is proposing a commercial Synthetic Aperture Radar (SAR) satellite constellation optimized for the MENA region with high temporal (4 Hrs.) and spatial resolution (sub 0.5 m, spot mode). With the trending demand for Earth Observation (EO) data for multiple civil applications, the MENA region appears to have a more dedicated space system that is calibrated to it.

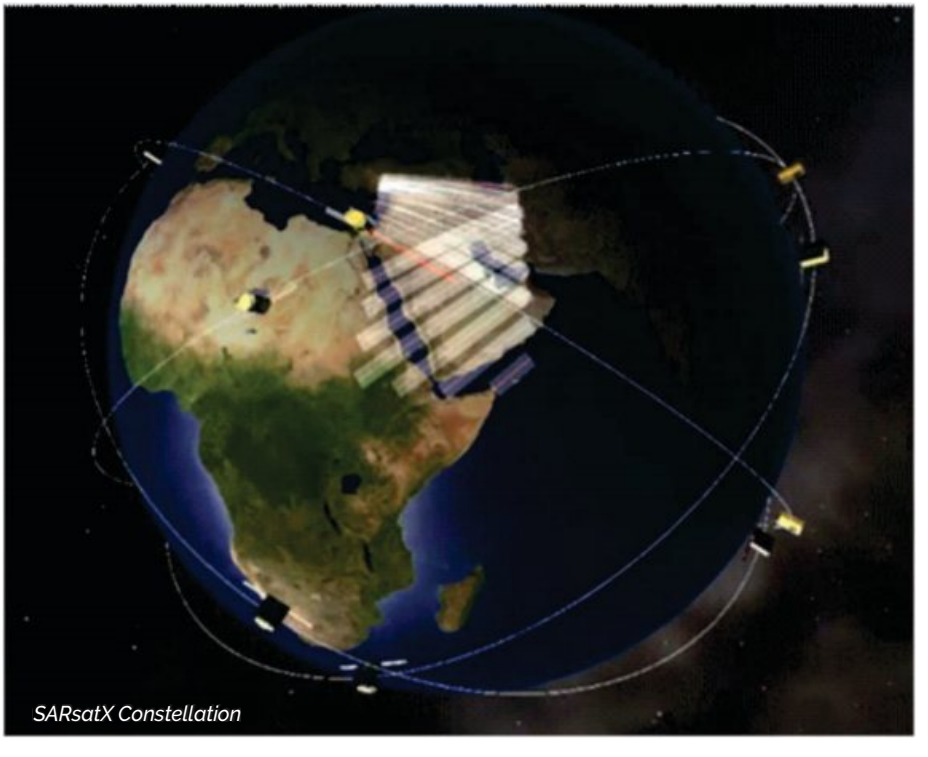
Unlike optical satellites, SAR can capture images during nighttime and penetrate cloud cover, allowing the capture of exceptional use cases. For example, monitoring mining activities, soil deformation with centimeter accuracy, agricultural damage, flood monitoring, oil spills, and more.

However, these rewarding capabilities come with a few penalties. SAR data is difficult to interpret without visual reference. This complexity makes it hard to sell, especially in a sunny region like MENA, where there are no clear advantages for SAR over optical.

The EO market remains small, excluding the defense and security sector (the most significant segment that pays for EO data). In addition, the civil EO market requires insights gleaned from data analytics.

Unleash SAR Potential

SARsatX aims to solve these challenges in the SAR market by fusing multiple EO data types at the beginning of the value chain, which means adding optical sensors (hyperspectral sensors) within the same platform of the SAR space system or in the sprite platform with formation flying (tandem pairs). In addition, to target the civil application and contribute to achieving Sustainable Development Goals (SDGs), SARsat is designing and developing a dual-band SAR system X, and L-Band with a high revisit time. L-Band, unlike X-Band, can penetrate through vegetation to give more insights like soil moisture, and data collection for crop health and better crop yields.



SARsatX Constellation

India is the world's second-largest producer of rice, wheat, sugarcane, groundnut, vegetables, fruit, and cotton. It is also one of the leading producers of plantation crops. The ability to monitor plantations with reliable sensors like SAR fused with Hyperspectral data in orbit significantly increases India's crop production.

Multiple SAR startups have launched X-Band sensors into the orbit, targeting the most prominent segment (security and defense) that only needs data, making raising a satellite company relatively less challenging. We, at SARsat, are considering SAR as the heart of EO data, but it isn't so valuable if it is not fused with optical and HS data to train it for interpretations.

Information instead of data

At SARsatX, we leverage the recent advances in Machine Learning (ML), which offers efficient tools for evaluating EO data and getting better and more relevant information. With on boarding ML algorithms in the spacecraft, delivering fast insights with less data is achieved. SARsatX is cooperating with AIKO space to run the

SAR processing algorithm on board the spacecraft, paving the way for cognitive space systems.

By using these algorithms, we can collect optical data to train onboard algorithms to get the final human interpretation quickly for SAR data.

Some of the key use cases for various applications include:

- Energy applications: Integration of supervision and intelligence by processing SAR data to monitor oil pipelines, monitor fracking, support offshore exploration, and detect dark vessels for the energy sector.
- Mining applications: Efficient resource planning and improved mining operations' safety based on information obtained from SAR data to create 3D volumetric mapping and measurement tools and monitor mining activity, tailing dam integrity, surface water extent, and ground subsidence.
- Insurance applications: Recent SAR data for parametric insurance, claims, loss adjustment, and risk reduction in urban flood monitoring, agricultural flood monitoring, property damage estimation, property assessment, and infrastructure integrity monitoring.
- Civil/government applications: Regular SRR data for better regulations and public safety by studying new construction patterns, monitoring forestry and agriculture, monitoring infrastructure integrity, and reducing landslide risk.
- Environment applications: Change detection insights of consecutive SAR images for special forces to identify unlawful deforestation activities for environmental security.

The merits of SARsatX

We believe that Distributed SAR Systems with optical sensors fusion (D-SAR) will disrupt the entire EO market because it is an effective and efficient way to unlock the real-time EO data and make the most of SAR capabilities (visibility at night and through clouds).

While emerging SARs complain about customers not appreciating SAR data and trying to build empathy around it (customers will never abandon optical satellite imagery), they completely neglect to push the envelope towards D-SAR that unlocks the real potential of SAR sensors. Instead of showing customers black-and-white images, developers should build systems to allow machines to consume and process enormous amounts of data to deliver helpful information to customers on the maps they use.

SARsatX focuses on designing and developing an unprecedented, distributed SAR system. A group of Formation Flying Synthetic Aperture Radars (FF-SARs) with optical sensors in formation; multiple co-flying platforms work together to carry out novel and complicated SAR – optical missions.

Image Credit: ICEYE

What is Earth Observation?

Satellite data or satellite imagery is understood as information about Earth and other planets in the space, gathered by man-made satellites in their orbits. The most common use for satellite data is Earth Observation (EO) where satellites deliver information about the surface and weather changes on the Earth.

Opportunities

Satellite data is generated via remote sensing technologies. One of these, Synthetic-Aperture Radar (SAR) technology, provides reliable and timely data stream opportunities for a myriad of applications at land and sea. For governments and organizations, this means possibilities for acting on time as in natural catastrophes and crimes, for businesses this enables developing completely new and improved services.

Authentic Data

One of the inherent values that satellite data has is the availability of authentic information about Earth surface, weather, and other incidents. Cumulative data helps to understand developments in long-term and timely data to act swiftly on the detected issues.

The EO data comes from spaceborne platforms with remote sensing tools. Earth Observation through satellites relies on the use of their mounted payloads which collect and transmit images or other data of the Earth's characteristics.

The Earth Observation satellites are normally launched to relatively low altitude orbits (about 600-800 km from the surface of the Earth) to be able to carry out their imaging tasks.

Progressing the 75SSM...

The team's approach to assisting the collaborating institutions, technology building, and program management in realising their mission objectives is aggressive and appreciated.

In the light of the downturn in the global semiconductor sector and the interruption of crucial component supply chains, the Technology team has continuously working to revalidate designs. The Program Management teams have been focusing on expanding partnerships and alliances to integrate global vendors and partnering institutions.

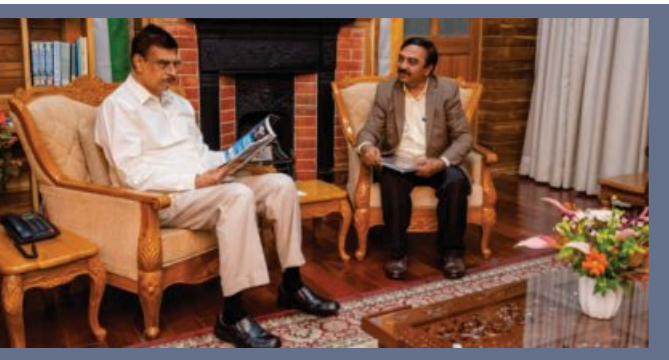
Also, the Technology teams have been working with renowned space-tech practitioners to propose and test product insights to ensure alignment with mission goals. Meanwhile, by successfully completing their individual assignments and tasks, the Delivery teams have been concentrating on achieving the programme's milestones on time.

Mizoram, Puducherry, Gujarat, and Karnataka are just some of the states and union territories where the Leadership offered opportunities and presentations on the mission's aspirations to the respective Governments. As a direct result of these discussions with the Honorable Governors and Chief Ministers, 75SSM have seen significant momentum with the Universities, Technical Institutions, and the Department of Public Instruction/Ministry of Education in the respective States on the collaboration front.

The number of institutions participating in the mission has been growing consistently. The ITCA teams have been travelling across the nation to engage with the management and faculty of leading educational institutions to familiarize and advocate the adoption of the mission.

ITCA successfully broadened the consortium base to include companies that provide innovative solutions for design and engineering, as well as systems integrators, service providers, learning organizations, professional societies, not-for-profit bodies, international space tech organizations, and technology vendors. As a result, from June '22 till now, we have signed 28 agreements and MOUs to benefit the mission's progression.

In addition, several organizations have signaled their wish to join the mission, and ITCA is in the process of having conversations about their participation.



ITCA Board Member Dr S K Prasad with
His Excellency Governor of Mizoram, Dr Hari Babu Kambhampati

ITCA Advisor, Padma Bhushan Awardee, Dr A Sivatanu Pillai and
Dr K Gopalakrishnan with Her Excellency Lt Governor of Pudhucherry,
Dr (Tmt.) Tamilisai Soundararajan

ITCA President, Secretary General and Board Member with
His Excellency Governor of Karnataka, Shri Thawar Chand Gehlot

MoU Signed for Gujarat University in the presence of
Shri Bhupendrabhai Patel, Hon'ble Chief Minister of Gujarat

MoU Signed for Gujarat Technological University in the presence of Hon'ble Chief Minister Education Minister, Chief Secretary and Principal Secretary of Gujarat

M.S. Ramaiah University of Applied Sciences, Bangalore

Marwadi University, Rajkot

South Point High School, Kolkata

Seshadripuram Educational Trust, Bangalore

Overall, the consortium is very active, and members frequently exchange concepts and strategies to maximize the mission's value to all stakeholders.

The 75 SSM Consortium has chosen six teams to participate in the World CanSat Rocketry Championship finals, which will take place in Novi Sad, Serbia, from 25-27 September 2022. These teams were provided thorough training by ITCA to assist them with building their CanSats so as to participate in the competition.

At the ITCA Technology Centre in Bengaluru, we have installed a ground station as part of a pilot programme to test and evaluate various functionalities. The outcomes are encouraging, and we will be finalizing the configuration for the ground stations to be installed in other participating institutions based on their readiness with the infrastructure.

The Mission team is now coordinating with the participating institutions to set up Amateur Radio Clubs. There is potential for the institutions to establish HAM Clubs supervised by a qualified HAM operator. Participating institutions are showing interest to take this to the next level for the benefit of students.

The teams are having an exhilarating and fulfilling journey in progressing the mission, engaging with students who will be critical members of tomorrow's workforce and contributors to positioning India as a Global Space Hub. The body of knowledge and the experiential learning built by the participating students is humungous.

The technology teams are actively working with space-tech experts to review the designs and enhance the reliability of the various subsystems. These comprehensive reviews by multidisciplinary teams have successfully ensured that the finalized designs address all functional requirements and are enhancing assurance of the designs' adequacy.

The mission teams are also focused on identifying contemporary technologies and assessing state-of-the-art to ensure that the designs align with the global technology directions.

Mr Vinod S Chippalkatti, President, Strategic Electronics Business Unit,Centum Electronics Limited

Dr Vinod Kumar, Director, Promotion Directorate,
Shri Brijesh Kumar Soni, Deputy Director-PMAD, IN-SPACe

Shri H R Nagendra, Former Project Director, RNQA, URSC,
Shri S K Nagesha, IRS Project Director, URSC

Shri Gururaj B S, Chief Mentor - Content, Communication and Training

Žilvinas Kvedaravičius, BD Director, Julius Ašmonas, BD Manager,
Arnoldas Pečiukevičius, Head, Systems Engineering, NanoAvionics

Ms Shrisudha Viswanathan, Founder & CEO,
Edutech4Space FZ-LLC, UAE

Dassault Systèmes

Shri Jitu Vaghani, Hon'ble Minister of Education, Science & Technology, Govt. of Gujarat

Invited Article

Small Satellites – Big Paradigm Shift

India's New Space Economy Perspective

Mr Vinod S Chippalkatti
President
Strategic Electronics Business Unit
Centum Electronics Limited

Small is beautiful, but challenging as well. Small satellite technologies and applications in the overall global satellite market are experiencing a transformation in mass, number, and value of the satellites. Services from large satellites are actively considered for replacement with smaller satellites, which have several advantages when compared to the traditional satellites. The development and popularization of small satellites represent a shift in the traditional space sector. The space economy encompasses a much broader concept than the mere production and launch of spacecraft into the outer space. It includes the full range of activities and the use of resources that create and provide value and benefits to human beings while exploring, understanding, managing, and utilizing space.

The space economy consists of an upstream segment and a downstream segment. The upstream segment includes all activities that focus on the design, manufacturing, assembly, launch, functioning, maintenance, monitoring, and repair of spacecraft destined to be sent out to space as well as the products and services related to them. On the other hand, the downstream segment refers to all activities that employ data and knowledge derived from the space for Earth-related objectives and the products and services that support them.

Paradigm Shift

Hundreds and thousands of small satellites are planned to be launched in the coming years to address application areas, such as 'Internet for everyone and everywhere', earth observation with high-resolution imaging, asset tracking, Automatic Identification System (AIS), and many more. They incorporate the best technologies from the Industrial, Aerospace, and commercial world. The factors driving the small satellite revolution are:

- Latest technologies comprising materials, components, and methods
- Standardization of satellite bus
- Availability of platforms for testing newer technologies in cost-effective manner
- Reduction in the life cycle management of satellites
- Lower costs

Traditionally, small constellations of large and complex satellites have been installed in space to carry out desired operations. However, in the last decade, a new trend has been initiated by space industries where the idea of large constellations of small satellites has emerged in the market. This new idea has become feasible due to the rapid advancements in technology in recent years. In the coming years, big constellation systems of small satellites are expected to be more cost-effective with respect to small constellations of large satellites due to the miniaturization and launch costs.

The small satellite ecosystem culture is similar to a technology start-up and the maker movement, both of which encourage rapid innovation, at the trade-off for mission or platform assurance. This approach contrasts with the traditionally conservative space sector that emphasizes exquisite capability, long platform lifetimes, and high-reliability components. Like the conventional space ecosystem, Small Satellites also have their own ecosystem that comprises different players, such as industry (start-up and matured), academia, non-profit organizations, and the government. While the end-users continue to evaluate the benefits of small satellite-based applications vis-à-vis other terrestrial and aerospace domains, challenges such as debris mitigation, and regulatory and legal aspects need to be clearly defined.

India's New Space Economy

Of late, major subsectors, from launch to Earth observation, are increasingly being driven by commercial enterprises. This is a dramatic shift from the early days of government management of space activities. The sector is also becoming more segmented and globally integrated and is, therefore, more open to a variety of participants. In May 2020, the Indian government has thrown open the space economy to all the stakeholders such as start-ups, existing space industries, and academia. These reforms have arrived at the right time when the space ecosystem has already been created. Going forward, it is for the industry to do its part rather than be solely dependent on ISRO. Earlier, ISRO took the lead and responsibility for all space activities right from communications, weather monitoring, earth observation, defence, and all the downstream activities. The government reforms enable private players to take part in a larger portion of the ecosystem and help ISRO focus on scientific and other activities of national importance. New business models will evolve for private players to participate by leveraging the

ecosystem that is available and to further building on it to create a vibrant space economy.

Through the reforms, the space sector offers new opportunities to go up the value chain to the existing players and opens doors to new players. Every opportunity comes with some challenges, and one must evaluate them carefully before embarking on the journey.

India has the potential not only to address the internal demands but also to move ahead and compete in the upcoming demands of new space, constellations, small satellite launching, and an application-based space economy. The Indian space sector has an opportunity to create a vibrant ecosystem for start-ups and private enterprises.

Centum Electronics perspective

Located in the Space capital of India, Centum Electronics Limited (CEL), Bangalore is the leading Indian space industry responsible for the design, development, and delivery of highly complex space systems for India's satellite and launch vehicle requirements for over two decades, as illustrated in Fig.1.

The contributions cover both the build-to-print and build-to-specification modes where the journey from concept to commissioning is traversed at Centum. Some of the space products ranging from modules to subsystems to systems are shown in Fig.2.

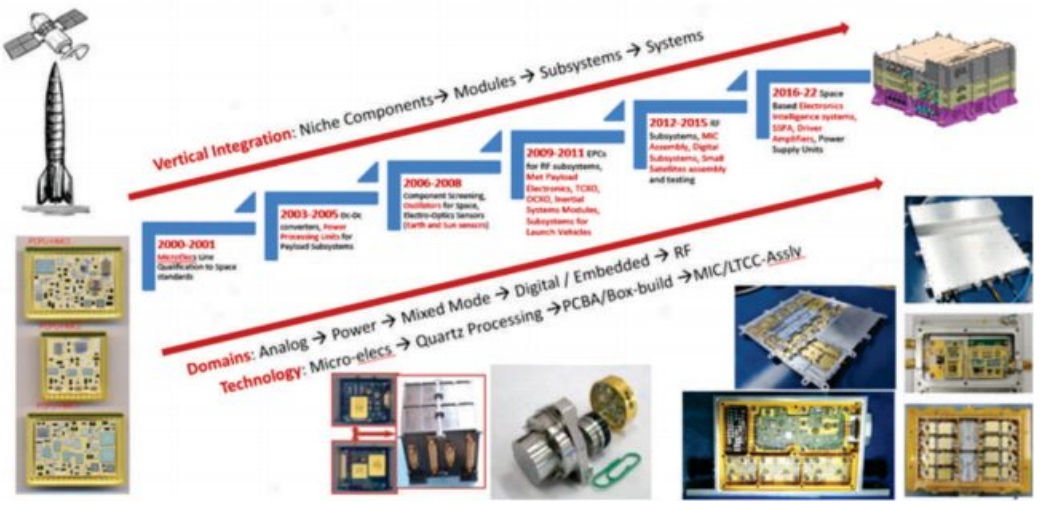


Fig.1 Credible Space Journey at Centum Electronics

Fig. 2. Examples of Products Developed at Centum Electronics

Conclusion

At Centum, we have over two decades of design and manufacturing capabilities with all infrastructure, technical resources, and flight heritage in the realization of various sub systems, systems, payloads for satellites, launch vehicles and in building of satellites.

As tremendous opportunities are opening in the Indian economy, which is growing as a major world economy, the role of Indian industries like Centum in the Indian Space sector will be crucial with established space infrastructure. A long association with ISRO has set the quality and reliability standards high for all the products designed and developed at Centum with an established complete infrastructure for manufacturing Small and Nanosatellites in India. Being one of the key partners with ISRO and with the encouraging environment created by the government of India for the private sector, Centum is ready to support space industries/start-ups with its established space infrastructure and contribute to the Indian space sector in the coming days.

CEL has joined Indian Technology Congress Association Consortium to support the production and supply of the educational satellites for the program.

Inching Towards Self-Reliance
Enabled by a Skilled Workforce

Gururaj BS
Chief Mentor - Content, Communication and Training
75 Students' Satellites Mission

"Necessity is the mother of invention," said Plato, a Greek philosopher. Ever since the advent of humankind, we've found the constant need to invent or discover new things to satisfy our needs or to solve a problem. The need for self-reliance in technology led to the emergence of a plethora of new initiatives, programs, and creative efforts across India. It's been roughly two years since our prime minister unveiled "Atmanirbhar Bharat" and urged us to make our country self-reliant or Atmanirbhar. We all have a role to play in making this dream a reality. The key goal of this campaign is to make India and its citizens self-reliant and self-sufficient in all respects. Economy, infrastructure, and technology-driven systems are critical to the success of this campaign and other similar ones.

How did this begin?

On 21st November 1963, India launched a rocket into space. This event led to the inception of the Indian space program, which was founded by Vikram Ambalal Sarabhai. Widely regarded as the father of the Indian space program, Vikram Sarabhai envisioned that space services would reach and benefit ordinary people of India.We're witnessing definitive progress and rapid innovation in the space industry, and we're getting closer to achieving our vision every day. In the recent years, movies like Mission Mangal (a bollywood film made in the year 2019) grabbed the attention of ordinary people (that is, people with no familiarity or knowledge of space science) that gained some insight into the basics of the Mars Orbitary Mission and learned new terminology, such as PSLV, GSLV, payload, and so on. Of course, tech enthusiasts with a penchant for space science and technology have always been following news and developments related to the possibility of launching small satellites into the earth's lower orbit. Doyens and leading lights from premier institutions like Indian Space Research Organization (ISRO) have been guiding educational institutions, corporate houses, and technology start-ups with specialized learning programs and industry-academia partnerships.

Where do we go from here?

Technology has grown by leaps and bounds over the past two decades, and it is changing at a breakneck speed. No one thought it would be possible for students in India to design, develop, test, and launch satellites. What was once considered impossible or ludicrous is now within our reach. Inspired by the prime minister's vision to launch 75 student-built satellites to commemorate the 75th anniversary of Indian independence, the 75 students' satellites program initiated by Indian Technology Congress Association (ITCA) is designed to enable Indian academia to design, develop, and build small satellites that adhere to the CubeSat standard. In many ways, India's tech revolution has already left the West behind. Indian scientists, technologists, and research institutions have been instrumental in shaping the global economy. At this crucial juncture, we need to facilitate strategic partnerships between Indian academia and the industry, so the future workforce is prepared to capture a significant portion of the global space market.

ITCA is building a modern technology-driven system and platform for schools, colleges, and engineering colleges to learn, experiment, and practise, so they can complete student-built CubeSat missions on time, with guidance from stalwarts and icons from the Indian space program and the international space industry. Students participating in this program are privileged to rub shoulders with such distinguished experts, and participants should take the best advantage of this rare learning opportunity.

A number of premier educational institutions across the country are focusing on building or improving laboratory and hands-on infrastructure for their students. Some of them are able to achieve this goal by tapping on

Image Credit: Anna Shvets


Image Credit: Anna Shvets

resources and contributions from corporates, industries, alumni networks, and beneficial collaborations. It is clearly a step in the right direction. More and more institutions need to come up with strategic programs, plans, and initiatives to mobilize resources and investments, so the student community can gain access to more modern, robust infrastructure, systems, and learning environments. This will go a long way in determining how students can equip themselves with the right blend of skills needed to solve future challenges. Theoretical education or learning, imparted by several institutions, has a few key disadvantages:

- Emphasis is laid only on scoring marks in exams and assessments.
- Students don't gain "real" knowledge and "practical" experience. As a result, they struggle later in their careers.
- Experimentation is not generally encouraged.
- There is no importance of applications in the real world.

It is not enough for students to just have theoretical knowledge of science and technology concepts; they need to become "creators" by the time they graduate. In other words, they need to learn the art of innovating and creating new things. When they learn how to create new things, they can come up with potential solutions to real-world problems. The creator mindset gives students the tools and inspiration to achieve success through innovation. In many ways, the creator mindset is a journey of self-reflection, and it is the future of work.

The student satellites' initiative initiated and managed by Indian Technology Congress Association (ITCA) offers ample opportunities to students to learn how they can design, build, launch, and monitor small satellites. Such learning will come handy when students prepare to tackle on bigger and more complex challenges in their lives and careers.

How do we enable our students to succeed?

Here's how we can enable our students to succeed in today's world:

- Learn by doing
- Provide generations Y and Z with tools and resources so they can experiment, learn, and succeed

Learning by doing

While students read books, articles, blogs, and magazines to learn about new things, many of them like to learn through reflection on doing.

This is one of the reasons why ITCA has set-up a well-equipped, state-of-the-art technology development centre in Bengaluru, for the 75 Students' Satellite mission. In addition, ITCA has established partnerships and collaborations with other aerospace companies and organizations to facilitate access to their facilities and labs.

Provide generations Y and Z with tools and resources they can use to experiment, learn, and succeed

When compared to the baby-boomers, people from the Y and Z generations are most experimental learners. Their reading capacity is high, but their experimentation capacity is higher. In addition to leveraging ITCA's sophisticated labs and other facilities, students get ample opportunities to rub shoulders with ITCA's panel of domain experts. This combination of hands-on learning and expert guidance enables students and their educational institutions to succeed in the 75 students' satellite mission. Upon successful completion of the required training, students will have significant practical hands-on experience in systems engineering, AIT (assembly, integration, and testing), and post-launch satellite operations

What's coming soon?

Here are a few things we're working on:

- Leverage the power of technology to improve the process of learning and knowledge dissemination.
- Build a modern, simple, and robust learning platform to facilitate instructor-led training and self-paced learning.
- Explore options to personalize content on the website and on the learning platform.
- Increase collaboration and improve processes and tools used to build content for Technology Innovation Productization (TIP), our flagship publication.
- Build meaningful integrations of social media with our web properties, so the content updates reach all audiences.
- Create some good video content, such as interviews of domain experts, targeted at YouTube and Tik Tok users.
- Engage with as many learners as possible via various platforms to create awareness about the 75 students' satellites mission and to collect ideas and feedback.

I'm excited about the journey we've ahead of us. I look forward to sharing updates on our progress with you regularly. In the meantime, if you've any questions or suggestions, don't hesitate to email me. My email address is gururaj.bs@gmail.com.

Amateur Radio - CubeSats

An Exciting Integration

Amateur or HAM radio, is the non-commercial two-way communication utilizing the radio frequency (RF) spectrum for education & training, and emergency applications. The use of amateur radio on satellites dates back to 1961 when OSCAR 1 (Orbiting Satellite Carrying Amateur Radio) was launched. Today, we have a large number of satellites of all sizes, carrying amateur radio, being operated by "HAMs" in many countries across the globe. HAM radio provides access to a variety of frequencies from shortwave to microwave, for amateur satellite use.

The radio onboard a CubeSat is more than a simple command and telemetry link, it facilitates a HAM operator to carry out experiments using each of the satellite payload. In addition, as students earn their amateur radio license, they gain valuable and broad knowledge of communication techniques that can be applied to a variety of space related projects in spacecraft and ground station design, as well as terrestrial communications on Earth.

The term "amateur" is used to identify a licenced individual pursuing the radio hobby as a personal endeavour without any monetary benefit. HAMs are limited to the use of the amateur radio frequency bands, allocated throughout the electromagnetic spectrum. Within these bands, the HAM enthusiasts are allowed to transmit on any frequency using a variety of voice, text, image, and data communications modes.

CubeSats heralded an era of affordable access to Low Earth Orbits (LEO), and today, many individuals and educational institutions are pursuing initiatives to design, build, and operate these satellites. This experiential hands-on opportunity for students has increased significantly the widespread acceptance of the CubeSat paradigm.

The most commonly used frequencies by CubeSats are the very high frequency (VHF, 144-146 MHz) and ultra-high frequency (UHF, 435-438 MHz) bands. These have become extremely popular as they can be used without having to remit licence fees.

HAM activities are officially represented and coordinated by the International Amateur Radio Union (IARU), wherein the entire globe has been divided into three regions, and has as its members, national amateur radio societies from countries. There are more than three million radio amateurs across the world and they have acquired their licences to access specific frequency bands by qualifying in examinations on radio theory and practice.

Satellite Communication

Amateur satellite radio communication via LEO satellites is relatively simple, especially when using a dual-band (2m/70cm or 145 MHz/ 435 MHz) transceiver and repeater satellites. To effectively access and conduct first contact or conversation (QSO) via amateur CubeSats, many operators use a dual-band VHF/UHF hand-held transceiver (HT) and a simple light-weight dual-band hand-held Yagi antenna. Many operators have reported viable QSOs with a simple whip antenna and the HT for near overhead satellite passes.

For better results, committed users usually set up proper dual-band base-station rigs with a permanent rooftop antenna. In such cases, the best results are obtained by mounting crossed-Yagi or helical antennas on an azimuth/elevation (Az/El) rotator. These antennas have circular polarization and are best suited to reduce signal flutter and fading caused by signal polarization due to the constant tumbling of satellites in orbit.

A non-rotatable, omnidirectional antenna with a radiation pattern that covers the entire sky is another alternative for working with FM amateur satellites. The Eggbeater and the Quadrifilar Helical antenna (QHA) are two other popular options.

HAM Clubs at Academic Institutions

Educational Institutions including schools, engineering colleges, and universities can establish HAM Clubs to encourage students' participation.

The Wireless and Planning and Coordination Wing (WPC), a division of the Ministry of Communications and Information Technology regulates amateur radio in India and the operational characteristics of transmissions. It issues individual stations licenses to different clubs along with a call sign, which is a unique designation for a transmitter station.

HAM clubs require certification to transmit messages. Amateur Radio Club Station can be established in the Institution with a licensed HAM operator in charge of it. Anyone above 12 years of age can obtain Amateur Radio Station Operator's Licence after passing the examination/s- Restricted Grade, Grade II, Grade I, and Advanced Grade.

Receiving signals from satellites using one's own equipment is a fascinating experience for any space enthusiast. Space aficionados can also utilize their own hardware to talk to astronauts in space, and receive images from them. HAM Clubs can be the focal point for initiating and nurturing student satellite activity in Institutions.

Space Missions
Digital Adoption

A new golden era of space exploration has dawned on today's humanity. Both public and private organisations are participating in the metamorphosis of space in varying capacities. The commercially-driven space or the aeon of NewSpace has the potential to have a profound and far-reaching effect on our ways of life as well as our economy.

The notion of digital transformation can have multiple connotations depending on the sector, but it should be at the forefront of any business's consciousness if they are contemplating a shift to new frontiers. Leveraging digital technology intelligently has the ability to propel any business into the future while also providing increased speed and agility along the way. The space business, like any other sector, is embracing these capabilities with mission-driven reforms that are shaping every facet of technological advancement in the embryonic space era.

There are two key factors are driving the rapid commercialization of space. It is no longer restricted to launching rockets and developing satellites to unravel the secrets of the cosmos. It is now more about addressing challenges back on Earth to make it a better place for us all, and the subsequent generations.

Disruptions are common in contemporary space technology. Governments and other public institutions have traditionally driven space research and services, but market forces will drive tomorrow's advances in the space sector. As a result of these breakthrough innovations, we will continue to see the emergence of new service offerings including human spaceflight, in-space manufacturing, and next-generation communications.

Today's space industry is working at a very fast pace to integrate combination of diverse technologies and continue to show its dominance as an early adopter of innovation. For instance, artificial intelligence (AI) is being used by satellite and launch operators to streamline the licencing and regulatory filing process, Blockchain is being deployed to secure supply chains, augmented reality (AR) & simulation are being used to enhance mission assurance; and Cloud is providing a resilient backbone for space-based capabilities. Integrating these myriad technologies into new service offerings is ushering in purposeful, transformational change that enhances mission resiliency and lowers operational costs.

AI is being increasingly used to ingest weather and remote sensing data to provide real-time forecasts and insights. It is also being used to transform mass-produced CubeSats into a highly customizable platform for remote sensing and deep space exploration missions. Satellites with self-healing capabilities are being increasingly deployed to function as members of autonomous constellations.

Traditional space-tech organizations are continuing to climb the stack and enhance customer value. For example, ground station specialists are augmenting the value proposition for their customers with antennas to deliver end-to-end turnkey services across the value-chain. Data that hitherto used to remain in silos is now being made available to all stakeholders and integrated with mission operations to enhance the business engagement with their customers.

Today, conventional cloud service providers in the IT industry are automating processes and workflows in the space sector to augment ground stations' infrastructure and deliver multitude of space applications services, becoming a 'space' enterprise.

Breakthrough innovation in the field of networking and communications is offering a continuum of connectivity to drive the development of new products and services. For example, integrating AI with terrestrial and space-based weather sensors has already improved weather forecasting and accuracy; better user understanding has helped introduce this data into smartphones and mobile apps. Commercial satellite operators are building in-space edge routing and other networking platforms, mirroring terrestrial applications. Miniaturisation trends extend to satellites across all orbits, providing new connectivity methods for areas not served by fibre or 5G.

Today, satellite-based navigation services are available on billions of devices and is the most frequently used application on a smartphone. Every contemporary smartphone has a satellite navigation receiver, or GNSS (Global Navigation Satellite Systems) reception. This receiver can receive GPS, GLONASS, Galileo, and BeiDou


ITCA's AI Creation

signals, among others. When we turn on our mobile phones, it takes just 2-3 seconds to receive all the satellite signals and precisely calculate the location.

Advanced global connectivity solutions are building on latest developments in AI, image/facial recognition, and other such tools in the field. Working in tandem, techniques and capabilities such as computer vision, conversational voice, auditory analytics, advanced AR and virtual reality (VR) can transform how we engage with machines, data, and with each other. With tablet-based AR, technicians can move efficiently from one system or mission to another, optimizing the time for training and redeployment to address other critical activities. Technicians and astronauts can learn to repair machines virtually minimizing the need for actual equipment to be available for training purposes.

Forward-thinking organisations embed security, privacy, policy, and controls into their engineering and IT delivery models. This mindset is changing the cyber design philosophy across the space, launch, and ground segments, treating it more like an engineering and risk management exercise. Massive next-generation satellite constellations provide resiliency, as well as accurate identification of targets. As such, constellations require attention to cyber security, just like large-scale terrestrial networks. Finally, it is imperative to secure the supply chain by leveraging trusted foundries, subsystem manufacturers, and sensor suppliers.

While digitalisation has made its way into Industry 4.0 and transformed the terrestrial sector, digital transformation of the space industry is also seeing significant traction. The advent of NewSpace with the entry of private players is accelerating the pace of adoption and integration of key technologies, including the Internet of Things, machine-to-machine communication, cybersecurity, augmented reality, big data, autonomous robots, additive manufacturing, and 3D printing. Simulations are vital, particularly in space, where it is difficult to test, but the conditions and space environment can be mimicked, for detailed analysis using Hardware-in-the-Loop (HIL) lab equipment using a model-based, simulation-based systems engineering methodology, which handles such complexity.

The space systems industry is always looking for ways to build lighter-weight, higher-performance, reusable, and more reliable vehicles to reduce the cost of delivering payloads into orbit. This is being delivered through a collaborative, interactive and intuitive digital environment that combines mechanical, systems engineering, environmental testing, and program management to be able to visualize how a change in one subsystem could impact the functionality and performance of the integrated system.

Space is a challenging environment for electronics, causing numerous malfunctions and breakdown. The recent approach of launching constellations of satellites requires innovation and tweaking of processes to ensure reliability in space. Verification and validation need new ways for development and production. In the past, a spacecraft required several tests and levels to ensure proper operation. Individual testing of 1000 or 2000 constellation satellites in a particular project or mission timeline is difficult to accomplish.

It is essential to develop alternative approaches, such as type qualifying. This would entail undertaking full-fledged verification, qualification, and validation tests on the first model of the satellite, and then basis the qualification of that satellite, certifying the design and implementation for the subsequent satellites is taken forward.

Future spacecraft will include predictive failure detection, fault management, activity planning, health monitoring, and data management. This may be done autonomously in the future, initially on the ground and then on satellites. In the terrestrial AI sector, the legalisms are becoming better every day, and there's a drive for deep learning networks or intelligence to the edge. They are bringing in newline intelligence to edge devices that have minimal power and computing resources.

The classical verification and validation methodologies for software on spacecraft will also require a revision to cater to the new form of software based on computational intelligence. We will need to design new ways, and perhaps deploy statistical methods to verify that the software can manage a satellite in all operational modes. Using additional software-defined functions would make upgrades easier, and with a software patch, and the satellite would be upgraded.

Foreseeing the future, we can also consider in-orbit servicing before fuelling a satellite, lengthening its orbital lifespan, and even producing replacement parts in space. By equipping a spacecraft with a 3D printer, a spare component in space can be printed. Using the concepts of modularity and reconfigurability, it is possible to build a spaceship made of functional modules with standard interfaces that could be snapped together to create a new satellite.

Space presents limitless possibilities. In the new digital age, connectivity is an essential prerequisite for the digital transformation of nations. Only countries that achieve widespread deployment of the digital backbone would be able to bring in economic and social progress. Space is an enabler for the digital transformation.

MP BIRLA GROUP | COURAGE TO KNOW SOUTH POINT

PriyamvadaSat

South Point School

South Point High School

A legacy of excellence

- South Point, established in 1954 is run by the M P Birla Group.
- Affiliated to CBSE, New Delhi and has a strength of more than 12000 students with 455 teachers and 265 non-teaching staff.
- Featured in the Guinness Book of World Records for eight years from 1984-1992 as the largest educational institution in the world.
- South Point has produced enumerable toppers both in the Board exams and the Competitive ones.
- South Point has multiple National Award winners at the Initiative for Research and Innovation in Science (IRIS) and at INTEL-ISEF.
- South Point has Nobel laureate, several Bhatnagar Award winners, Fellows of Indian National Science Academy and Indian Academy of Sciences apart from many renowned doctors, engineers, chartered accountants, professors as its alumni.
- Wide range of co-curricular activities from Chess to Rowing. Has 3 Grand Masters in Chess and rowers of international standing.
- South Point is undertaking a relocation project, and by the year 2024, a sprawling campus over 6.65 acres of land in the eastern fringes of the city, with a built up area of around 900,000 sq. ft. is expected to be ready.

75 Students' Satellites Mission

ITCA's Engineering Prowess and Ingenuity

A space mission

Signing of the MOU by Shri Krishna Damani Trustee and Secretary, South Point Education Society, and Vice-Chairman, South Point High School and Dr. L V Muralikrishna Reddy - President ITCA at the School premises on August 2, 2022

PRIYAMVADA BIRLA CAMPUS OF SOUTH POINT

UNISEC-Global Meet
Bridging Academia to Space

S. Shanmugam
Manager
Indian Technology Congress Association

UNISEC-India hosted the 21st Virtual UNISEC-Global Meeting on the theme, **"Engineer Your CubeSat: Frugal Way to Access LEO."** This online global event organized on 21 May 2022 had over 200 delegates from 26 countries participating in the deliberations.

In his opening remarks, Dr L V Muralikrishna Reddy, President, UNISEC-India highlighted that the India operations of UNISEC has expanded exponentially despite global COVID pandemic impediments. Noting that while UNISEC-India was established in November 2018, its footprint has expanded to 48 local/institutional chapters in the country, emerging as the flag-bearer of promoting space activities amongst the academic institutions.

UNISEC-India had established its prominent stature with the launch of UNITYSat on 28 February 2021, as part of the PSLV-C51 Amazonia mission. Its founding members have gone on to pursue commercial ventures with the incorporation of start-ups TMISAT, Israel, and TSC Technologies. Twenty CanSat competitions have been organized across the country. These CanSat competitions have gained recognition as the medium for assessing the maturity of space-tech education in the country.

Highlighting the outcomes, Dr Reddy pointed out that UNISEC-India had extended the hands-on learning experience to the domain of CubeSats. Institutions, universities and schools have built collaborations and exchanged memoranda of understanding (MoU) to progress these noteworthy initiatives in their campuses. As a part of the 75 Students' Satellites Mission, UNISEC-India will engage with academic institutions to organize payload competitions, encourage publications and patents, establish ground stations, and support the development work on the institution's CubeSats. Dr. Reddy expressed his overall satisfaction at the path-breaking work done by the UNISEC-India team in expounding and establishing the StudentSat ecosystem in the country.

Presenting the 75 Students' Satellites Mission to the global audience, Dr Mylaswamy Annadurai, Padma Shri Awardee, and Former Director, U R Rao Satellite Centre, articulated the Prime Minister's vision of launching 75 satellites built by students from Indian schools and colleges to commemorate the country's 75th year of independence. This mission will enable an end-to-end life cycle experience for students and help them generate education and skills aligned with future jobs, that will be in huge demand in the next couple of decades.

Noting that the mission will be completed in about a year leveraging the ecosystem established by ITCA, Dr Annadurai brought out the strengths of the mission, which included students working on payloads based on contemporary technologies-LoRa Store and Forward, LoRa Inter-Satellite Communication, RF Beamforming studies, GNSS Reflectometry, Optical Radiometry, Amateur Radio Repeaters, amongst others.

The report on UNISEC-India Chapter activities was presented by Mr Nikhil Riyaz, Founder and CEO, TSC Technologies. Tracing the genesis of the India chapter to the announcement at the 6th UNISEC-Global meet at Strasbourg, France, he chronicled some of the important milestones, including the development of CanSat kits for educational institutions, and the development of cost-effective UHF and VHF ground station systems. He also

training opportunities, Dr Jayakumar Venkatesan, CEO, Valles Marineris International, outlined the exciting history of the development of the Soyuz spacecraft training simulators, and how this is driving the development of simulators for today's range of space activities, including the state-of-the-art Multipurpose workstations (MPWs). The participants were informed about the range of experiments planned in MPWs, which included body robots, survival of micro materials, evaluation of microorganisms' resistance to spaceflight conditions, and Nano sensors.

Mr Dusan Radosavljevic, Committee for Space Program Development (CSPD), Serbia introduced the World Cansat Rocketry Championship (WCRC), and its presence in over 60 nations across the globe. He also highlighted that the WCRC World Final will be held in Serbia in September this year and invited university students' teams worldwide to register and participate.

Prof R M Vasagam, Padma Shri Awardee and Chancellor of Dr. MGR and Karpagam Universities, envisioned the deployment of IoT applications on data monitoring and mapping of natural disasters. He opined that the current interest in small satellites and their constellations should be used for the implementation of civilian early warning systems that would help UN and national agencies in times of disasters. He nostalgically remembered that such a system was an unfulfilled dream of Dr Satish Dhawan, architect of the indigenous development of the Indian space program. He was of the opinion that ITCA could structure a roadmap for realizing this vision with participation by UNISEC and other UN organizations.

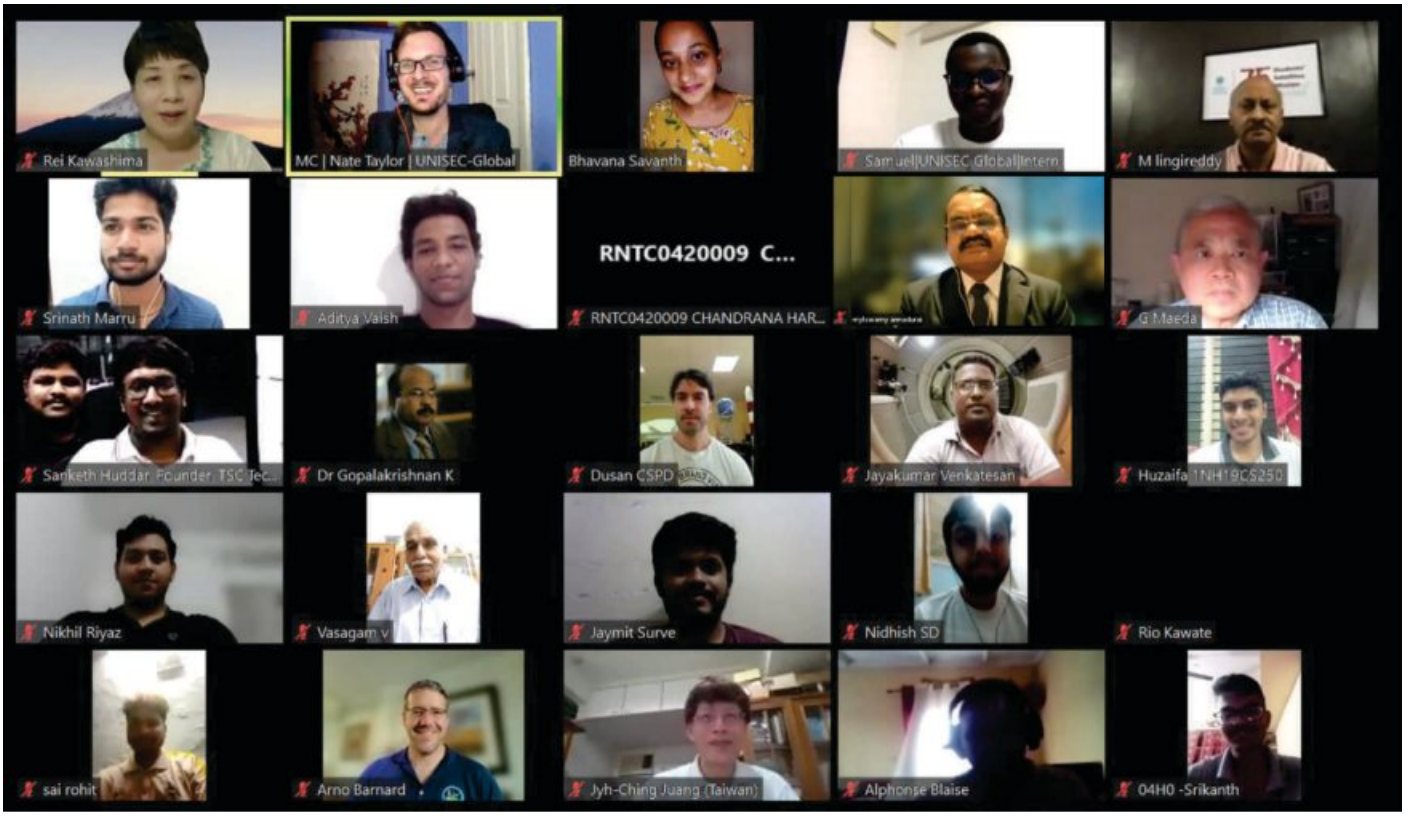
Summing up the proceedings, Ms Rei Kawashima, Secretary General, UNISEC-Global noted that this meeting got the highest record of 600 registrations with over 200 delegates participating in the global meeting. She thanked the vibrant support from UNISEC-India for organizing this meeting.

University Space Engineering Consortium (UNISEC)

UNISEC is a global non-profitable organization to support practical space development activities in universities and colleges, such as small satellite and hybrid rockets. Since its establishment in November 2013 in Japan, UNISEC has provided a forum every year to promote practical space development activities, mainly at university level, such as designing, developing, manufacturing, launching and operating micro/nano/pico satellites and rockets, including their payloads.

Vision

"By the end of 2030, let's create a world where university students can participate in practical space projects in all countries."



Global Student-built Satellite Activities

Universities are adopting Student-built satellite development activities as an experiential, hands-on programme to complement the academic curriculum. This innovative space-tech project facilitates students to gain skills that are relevant to the industry's needs and prepares them for a fruitful career in the space sector.

The following content is a compilation of student-built satellite activities pursued by various global institutions and universities to prepare the workforce for a career in space.

University of Waterloo (UW)

Fuelled by passion for space as the final frontier, UW Orbital is building a 3U CubeSat "Eternium-III" to compete against other universities in the upcoming Canadian Satellite Design Challenge scheduled for 2023.

Approximately 70 members, who are mainly engineering students, are developing a single three-unit CubeSat, which is about the size of three Rubik's Cubes stacked together or a milk container.

A low-cost alternative to traditional multimillion-dollar satellite projects, a CubeSat allows smaller organizations like student teams to become involved in space initiatives.

About a dozen post-secondary institutions from across the country will take part in next year's Canadian Satellite Design Challenge to be held in Ottawa. The first prize is funding to launch the winning school's CubeSat.

Supervised by Prof. George Shaker-adjunct associate professor at the Department of Mechanical and Mechatronics Engineering as well as the Department of Electrical and Computer Engineering at University of Waterloo, UW Orbital is a re-branded version of the UW Satellite Team (WatSat) that operated from 2010-2018.

Many members of WatSat and other CubeSat teams are providing mentorship to UW Orbital as it builds its entry for the design challenge as well as a space community within the University of Waterloo.

https://uwaterloo.ca/news/engineering-students/teaming-go-above-and-beyond

AFRL NanoSat Mission

The Air Force Research Laboratory's University Nanosatellite Program (UNP) has selected 10 universities to participate in the upcoming 2-year partnership to design, fabricate and test small satellites.

At the recent Flight Selection Review for the program's tenth cycle, 3 of 10 universities were chosen to remain in the program and continue the development of their CubeSats. These universities will be provided flights to space upon completion of their satellites. The universities selected were:

- The University of Minnesota
- Texas A&M University
- Michigan Technological University

The UNP has also notified 10 universities selected to participate in the upcoming 11th cycle. The universities are;

- Saint Louis University
- University of Alaska Fairbanks
- University of Colorado Boulder
- University at Buffalo
- The State University of New York
- Western Michigan University
- University of Maryland
- Auburn University
- University of Texas at Austin
- Rutgers University
- Purdue University

The objective of UNP is to promote and sustain university research and education focused on small satellites and related technologies.

""Throughout the 2-year program, student participants will design, fabricate, and test a small satellite," said Col. Eric Felt, director of the AFRL Space Vehicles Directorate. *""We also hope to foster research in enabling technologies, and the design of experiments that can be performed by small satellites in orbit. We are helping to develop the pipeline for the burgeoning space industry."*

In addition to 10 education-focused partnerships, the Georgia Institute of Technology has been selected for a unique experience- a mixed technology and education-focused partnership working directly with an AFRL program.

https://www.afrl.af.mil/News/Article/2852221/afrl-selects-10-universities-for-prestigious-satellite-program/

Strathclyde and National University of Singapore to co-ordinate quantum communications

The University of Strathclyde and the National University of Singapore (NUS) have signed a memorandum of understanding (MoU) on satellite quantum communications, to pave the way for increased joint experiments between the institutions.

Under the agreement, the universities will coordinate so that optical ground

stations used by the institutions are able to receive signals from satellites operated by each other.

The MoU is designed to build an international team that shares a consensus on the range of wavelengths used in quantum communications experiments from satellites. Frequency coordination efforts of this kind are regularly carried out in conventional communications.

Dr Daniel Oi, Senior Lecturer in Strathclyde's Department of Physics, *"This is a tremendous opportunity to demonstrate truly global communications secured through quantum means."*

Associate Professor Alexander Ling, a Principal Investigator at the Centre for Quantum Technologies (CQT) at NUS, *"Through this MoU, we will ensure that our respective satellites and ground stations can talk to each other so that we can do joint work on quantum communication."*

Previously, Dr Oi and Professor Ling collaborated to develop quantum entangled photon sources suitable for satellites, to translate laboratory systems into miniaturised components capable of functioning under the harsh conditions of launch and orbit, and to enable the development of space quantum technologies.

CubeSats, a standard type of nanosatellite made of multiples of 10 cm × 10 cm × 10 cm cubic units, were used for the rapid development and testing of devices and systems at a much faster rate and lower cost than traditional space engineering programmes. The team's work culminated in the launch of the nanosatellite SpooQy-1 in 2019. This work has inspired similar CubeSat space quantum technology projects worldwide.

https://www.strath.ac.uk/whystrathclyde/news/2022/strathclydeandnationaluniversityofsingaporetoco-ordinatesatellitequantumcommunications/

NASA Announces 13th Round of CubeSat Space Missions

NASA has selected eight small research satellites from seven states to fly as either auxiliary payloads or deployments from the International Space Station (ISS). These missions are currently planned to launch in the 2023-2026 timeframe. The selected CubeSats were proposed by educational institutions, non-profit organizations, and NASA centers in response to NASA's CubeSat Launch Initiative (CSLI) call for proposals issued in August 2021.

"CSLI fosters innovation in the science and technology community by launching CubeSats built by diverse organizations - from middle schools to NASA Centers," Samantha Johnson, Launch Services Office, NASA Headquarters. "These partnerships benefit NASA, commercial launch partners, and participants by providing a low-cost pathway to launch small satellites conducting scientific investigations, technology demonstrations, Earth observation, and more."

CSLI 13th Round CubeSat Selections

The organizations and the CubeSats chosen during this selection round are:

- Arizona State University
- University of Illinois at Urbana-Champaign
- NASA Langley Research Center
- California Polytechnic State University
- Olin College
- University of New Hampshire
- Utah State University
- Arizona State University

https://www.nasa.gov/feature/nasa-announces-13th-round-of-candidates-for-cubesat-space-missions

Schools Satellite Project (SSP)

The goal of the Schools Satellite Project (SSP) is to give a group of secondary schools from across the world the opportunity to plan, build, launch, and operate their own miniature satellite, i.e. a Nano Satellite or a Cube Satellite.

In pursuing its objectives, SSP will engage with key enabling stakeholders including universities, industry bodies including satellite manufacturers and space agencies and others involved in the operation of satellites.

Through participation in this project, high school students will have the opportunity to gain hands-on experience in the construction and operation of a tiny satellite as well as the collection and analysis of data utilising satellites. As part of this, the mission objectives and the instrumentation on the satellite that will collect data to fulfil the mission objectives will need to be designed.

The project is built to fit in with curricula and offer participation modules providing positive inputs to diverse school content, including science, medications technologies, computer skills, data analytics, coding, project management, team working, English language skills, amongst others.

Source: schoolssatelliteproject.com

RAMAIAH UNIVERSITY OF APPLIED SCIENCES

www.msruas.ac.in

WE CREATE
LEADERS

RAMAIAH SAT

M S Ramaiah University of Applied Sciences (MSRUAS) is set to build a student satellite namely, 'Ramaiah SAT'. Gokula Education Foundation (GEF) along with Ramaiah University of Applied Sciences have signed a Memorandum of Understanding (MoU) with Indian Technology Congress Association (ITCA) to develop and assemble the satellite. This initiative coincides with the participation of MSRUAS in 75th Year of Indian Independence (Azadi Ka Amrit Mahotsav) through the initiatives of Students' Satellite Mission of launching 75 Satellites and Centenary year celebration of Founder Chairman Late M.S. Ramaiah.

Ramaiah Group has the legacy of nurturing the talents in the field of education and healthcare for 61 Years. RUAS, established in 2013, built on the legacy of Ramaiah Group of Institutions focuses on student-centric higher education in preparing them to meet the future challenges through experiential learning with Industry 4.0 infrastructure and faculty gearing up for the implementation of NEP 2020. The faculty of Engineering & Technology is housed amidst the industrial hub at Peenya, Bengaluru.

Sponsored Research (INR 800+ Lakhs Sanctioned)

SCHOLARSHIP FOR MERITORIOUS STUDENTS

HIGHLIGHTS:

- Applied Learing in World Class Facilities
- Start-up Support from Technology Development Fund (on Campus)
- Internship, Training & Placement Support
- National and International Placements

A+ | nirf ALL INDIA RANKING 2022 | 38th Ramaiah Medical College | 14th Faculty of Design Sciences | 62nd Faculty of Pharmacy | ARIIA ATAL RANKING OF INSTITUTIONS ON INNOVATION ACHIEVEMENTS

- Patents Filed - 190
- Patents Awarded - 32
- Industrial Consultancy Projects - 550+
- MoUs with Universities Abroad and Industries - 50+
- Citations - 8,488

⇨ On Campus :
- Technology Business Incubator
- Industrial Consultancy Centre
- Institutional Innovation Council

FACULTIES:

- Faculty of Engineering & Technology
- Faculty of Art & Design
- Faculty of Mathematical & Physical Sciences
- Faculty of Pharmacy
- Faculty of Management & Commerce
- Faculty of Hospitality Management & Catering Technology
- Faculty of Dental Sciences
- Faculty of Life and Allied Health Sciences
- Ramaiah Medical College
- Ramaiah College of Physiotherapy
- Ramaiah Institute of Nursing Education and Research
- School of Social Sciences
- School of Law

AWARDS & RECOGNITIONS

KSURF | I-GAUGE

Gnanagangothri Campus:
University House, New BEL Road, MSR Nagar, Bangalore-560054

Ramaiah Technology Campus:
#470-P, Peenya Industrial Area, Peenya 4th Phase, Bengaluru-560058

Contact: Dr. Sharath Kumar K. M.
Director Research
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99005 14038 | 080 4536 6666

University Website:
https://www.msruas.ac.in/

Bengaluru Space Expo

Confluence of SpaceTech Expertise

ITCA Consortium showcased the range of space-tech capabilities at the Expo including:

- Design of CubeSats in partnership with the Academia
- New Product Development including GNSS Simulators and ADS-B Solutions
- Design, Development and manufacture of Ground Stations
- Fabrication and Realization of Student-built CubeSats
- Training and Human-in-Space Flight Simulation Solutions

The 7th Edition of Bengaluru Space Expo 2022 (BSX) was successful in demonstrating the products of 145 private, public sector companies and academia. Several Agreements have been signed at the BSX, organised in association with the Indian Space Research Organisation (ISRO), the Indian National Space Promotion and Authorisation Centre IN-SPACe and NewSpace India Limited (NSIL). In the context of India opening up the space sector to private entities, the expo has served as the meeting ground for all stakeholders from India and abroad to engage and explore opportunities for synergy.

In a significant milestone establishing India's new growth trajectory as a global space hub, Hindustan Aeronautics Limited (HAL), and the L&T Consortium signed an agreement with NSIL to manufacture five Polar Satellite Launch Vehicle rockets. The first one would be delivered in 24 months, and the remaining 4 in the following 6 months. The successful demonstration of the initial orders would result in follow-on orders of 14-15 rockets for the consortium.

The expo had a booth by the Indian Technology Congress Association (ITCA) to highlight student-built CubeSat development activities being progressed in partnership with academia including schools, engineering institutions, and universities.

Shri S Somanath, Chairman, ISRO

Dr Pawan Goenka, Chairman, IN-SPACe

ITCA Leadership Team with Roscosmos

ITCA Leadership Team with IN-SPACe

Students @ BSX 2022

ITCA Exhibits @ BSX 2022

ITCA Exhibits @ BSX 2022









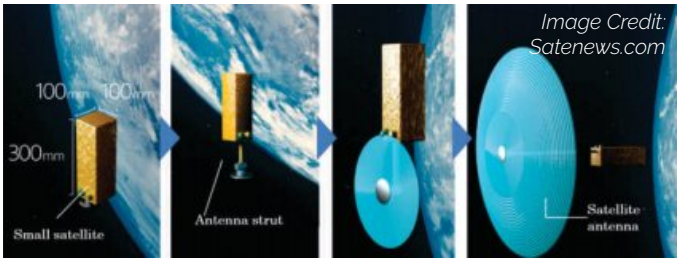


3D Printing Satellite Antennas in Space

Mitsubishi Electric Corporation announced that it has developed an additive manufacturing technology based 3D print satellite antennas in space. This novel technology uses a newly developed liquid resin with a low-power process that utilizes the sun's ultraviolet rays for hotopolymerization.

The 3D printer extrudes a liquid resin that hardens into a rigid solid when exposed to solar ultraviolet rays. Using this technology, it is possible to manufacture a parabolic antenna that is both larger and lighter than a conventional antenna.

Mitsubishi Electric reported that it printed a prototype parabolic antenna with a diameter of 165 mm and confirmed a gain of 23.5 dB at 13.5 GHz in the Ku-band. The company received a patents for both 3D printing technology and for the development of a resins that can be cured by the sun's ultraviolet rays, even in vacuum.



On-orbit manufacturing and deployment of a satellite antenna in space (from left)

The company said with this development a satellite's antenna size does not have to be limited by the size of the fairing of the launch vehicle or the size of the satellite bus, which is currently a constraint. This could allow small satellites to achieve large-satellite capabilities.

Source : satellitetoday.com

Satellite Services Revenue
to hit USD 1 Trillion by 2031

Euroconsult is forecasting a trillion dollar "explosion" in the satellite market by 2031, driven by a shift to data-driven applications and the rise of pay-as-you-go, service-driven approaches. In their new report, Satellite Connectivity and Video Market, and in the presentation by Euroconsult Canada managing director Nathan de Ruiter, the team surmises that data applications will jump from 15% to 41% of total market revenue.

This shift could make them over $1.2 trillion by the end of 2031.

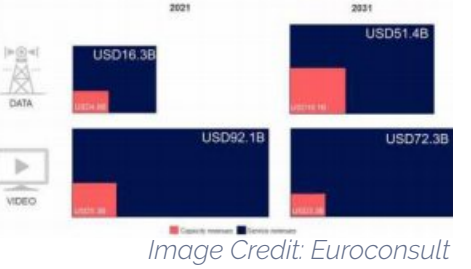
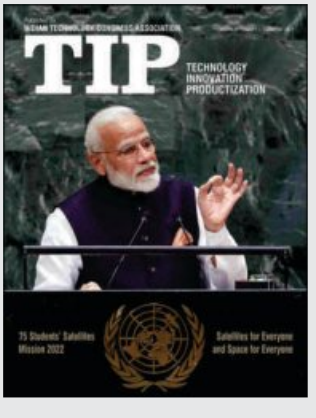
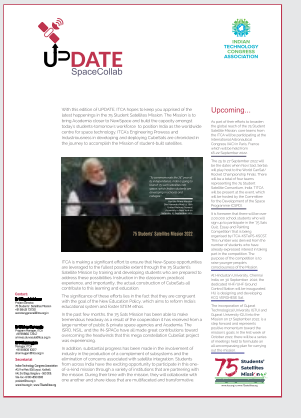


Image Credit: Euroconsult

The other shift is the increasing use of "non-geostationary orbit satellites" (NGSO), like those in low earth orbits or polar orbits. Their release said that *"the rapidly growing importance of NGSO in connectivity markets is heavily impacting the Fixed Satellites Service (FSS) industry, with an increasing number of players looking at a multi-orbit strategy to expand their business, as highlighted by Eutelsat's recently announced merger with OneWeb."*

Source : spaceq.ca





https://75satellites.org/downloads

Invited Article

Insurance and Space Missions

Karthikeyan S
Prashanth U
Partner
MyAnmol Insurance Brokers LLP

The space insurance industry is composed of three main groups: (1) Insurers/Reinsurers and Brokers; (2) Insured (which includes manufacturers, launching agencies, operators, and users); and (3) Users, such as TV stations, telecoms, banks, car manufacturers, Educational Institutions, etc. Because operating a satellite is an expensive and high-risk endeavour in space, from the moment it is launched until the moment it is decommissioned, the insured will derive the greatest possible value from a space insurance system in each individual component.

Space and satellite insurance has evolved from single-launch coverage to a complex disciple combining contract analysis, risk evaluation, alternate risk transfer concepts, insurance program design, implementation and claims negotiation.

The traditional space insurance market guarantees that the value of satellites that have been installed in orbit around the planet will not diminish. In contrast, satellites held by the government or armed forces are normally self-insured, but spacecraft owned by private enterprises, academic institutions, or startup companies are typically necessitated to have insurance.

Cube-shaped satellites, often known as CubeSats or Cube satellites, are far less expensive than conventional, bigger satellites. There are now a number of microsatellites in operation for testing technological breakthroughs and innovations. Smaller satellites are more prone to damage than larger ones, and their shorter lifespans may also be disadvantageous.

The differences between conventional satellites and microsatellites have an effect on the factors that are taken into consideration when obtaining insurance. The concept of small satellites has been around for a while, but in comparison to more conventional satellites, their history of accomplishments is not entirely compelling. There is still a paucity of experience in effective launch operations and in-orbit phases among institutions and private entities. The track record of the space business, the parties involved, and the history of earlier designs for tiny satellites will all be taken into consideration by insurance firms. Because of this, the type of insurance coverage or the level of protection that the insurance company offers to the aerospace industry will be contingent upon the aforementioned criteria. There is a specific reason to be concerned, and that reason is the numerous dangers that are involved with activities that take place in space. Insurance companies are unable to effectively manage an infinite risk in terms of both quantity and duration; as a result, premiums must be kept high in order to maintain a sufficient level of protection.

As a result of collaboration between aerospace customers, insurance brokers, and insurance companies, many distinct types of satellite insurance plans have been devised. As more time has passed and the insurance sector has become more established, it has continued to offer a more comprehensive range of insurance coverage. The two most typical kinds of satellite insurance are property insurance and liability insurance that extends to third parties..

Property Insurance

- Manufacturing and pre-launch activities
- Launch into Space
- In-orbit life

In terms of Pre-launch Insurance, the satellite is insured during the pre-launch phase for any loss of value or harm to its physical condition that may occur. During this phase, tasks such as transporting the satellite, temporarily storing it in the launch region, integrating the satellite with the launcher, and configuring the satellite will occur. Additional preparations that must be made before the launch include purchasing payload loss coverage and packing fuel for specific terms.

Launch Insurance

- The actual launch, as well as the cost involved for the transponder.
- An extensive amount of time during the early life-cycle of satellite operation
- The coverage for "loss of operation" of a satellite (such as transfer into orbit and longevity is based on estimations of initial deployments)- The remaining life of the spacecraft after the minimum coverage term is typically at least 180 days of fuel or power loss. This is done so as to assure that the spacecraft has to the claim. During the course of its orbit, it is prone to solar eclipse cycles.

In-orbit Insurance/"life" Insurance

- Proper functioning of the satellite during its operational lifetime, usually in yearly renewable phases.
- Third-party liability Insurance
- Preparations for launch
- The lift-off
- In-orbit operations of a satellite program
- Re-entry

The legal liability arising from damage (damages occurring when a satellite, a rocket, or its components fall to the ground; damages from fire during ignition; damages from an explosion of a satellite in orbit; and damage from the collision of the satellite with another spacecraft) to third parties. Compensation is provided for personal injury and property damage to third parties, both on the ground and in space, caused by the launch vehicle or the satellite.

Reflections

P K Thiagarajan
President
Institution of Valuers (India)
New Delhi

We are pleased to see that ITCA is using the space industry to introduce students to the demands of the field. Students will gain knowledge of the crucial elements of designing systems while taking into account various design limitations by moving the project forward under the direction of mentors from the space sector. They will get valuable project management skills while learning how to optimise designs. They will be capable of working confidently and clearly on significant multidisciplinary engineering projects. Students at colleges that work with ITCA have a clear edge when showcasing their skills to potential employers.

Ravi K S
Former Sr Dy General Manager,
CADDS (Central D&E)
Bharat Electronics Ltd

The deregulation of the space sector is opening up new vistas for innovation and research, and the space sector would need significant collaboration with the academic institutions to meet the upcoming requirements in science and technology. The 75 Students' Satellites Mission is an excellent platform for building collaboration between industry and academia and utilizing specialized technical training programs for enhancing skills of students. It is essential for many universities and institutions to adopt this unique mission.

It is heartening to see ITCA reach out to school students to build a knowledgebase in space. Space is going to be the driver for economic progress in the coming decades, with significant revenues coming in through the "space-for-earth" activities. It sparks curiosity in students and facilitates a deep understanding of science and technology subjects. With students from over 75 institutions participating in this unique mission, we would be building significant capacity in India to progress space programmes, as today's students will be the workforce of tomorrow.

Dr K Ramachandra
Former Director
Gas Turbine Research Establishment
DRDO

Bh Appi Reddy
Managing Director
Mohan Krishna Polymers
Hyderabad

ITCA's 75 Students' Satellites Mission has at its core the key concept of experiential learning. Utilizing CanSats as the medium to teach students the basics of satellite technology is a progressive method adopted to align Indian academia with global practices to introduce and build competency in satellite development. I am impressed with the depth of global linkages that have been established by ITCA. Students going through this mission will have significant exposure to the best practices in CubeSat development and will build actionable synergies with faculty in globally recognized universities.

V K Sashi kumar
Director - Multidata Services Pvt Ltd
Thiruvananthapuram

ITCA has made a "leap of faith" to educate satellites and satellite operations to high school and engineering students. The programme provides a foundation on a broad range of topics that students will find valuable in their professional careers. The hands-on programme is designed to offer sufficient inputs for hands-on learning. Students have the opportunity to connect with ISRO and industry professionals on essential areas such as earth observation and remote sensing, agriculture, navigation, transport, and communications, thereby gaining the ability to integrate technology into applications.

ನಿಸರ್ಗದೊಂದಿಗೆ ಸಹಬಾಳ್ವೆಗೆ ಪ್ರೋತ್ಸಾಹಿಸೋಣ

- ನೈಸರ್ಗಿಕ ಸಂಪನ್ಮೂಲಗಳನ್ನು ಮಿತವಾಗಿ ಬಳಸೋಣ
- ಮಳೆನೀರು ಕೊಯ್ಲು, ಅಂತರ್ಜಲ ಮರುಪೂರ್ಣ ಮಾಡೋಣ
- ಕೆರೆ, ಕುಂಟೆ, ಜಲಸಂಪನ್ಮೂಲಗಳನ್ನು ಸಂರಕ್ಷಿಸೋಣ
- ಮರಗಿಡಗಳನ್ನು ಬೆಳೆಸಿ ಸಂರಕ್ಷಿಸೋಣ
- ಸೌರಶಕ್ತಿ, ಪವನ ಹಾಗೂ ಇತರೆ ನವೀಕರಿಸಬಹುದಾದ ಸಂಪನ್ಮೂಲಗಳನ್ನು ಪ್ರೋತ್ಸಾಹಿಸೋಣ
- ಕಸವಿಂಗಡಣೆ ಮಾಡೋಣ ಹಾಗೂ ತ್ಯಾಜ್ಯ ಉತ್ಪಾದನೆ ಕಡಿಮೆಗೊಳಿಸಲು ಕ್ರಮವಹಿಸೋಣ
- ಪ್ಲಾಸ್ಟಿಕ್ ಬಳಕೆ ತ್ಯಜಿಸೋಣ
- ನಮ್ಮ ವಾಹನಗಳ ಹೊಗೆ ಪ್ರಮಾಣ ಮಿತಿಯಲ್ಲಿಡಲು ಕ್ರಮವಹಿಸೋಣ
- ಹಬ್ಬಗಳನ್ನು ಪರಿಸರ ಸ್ನೇಹಿಯಾಗಿ ಆಚರಿಸೋಣ
- ಕಾರ್ ಪೂಲಿಂಗ್, ಸಾರ್ವಜನಿಕ ಸಾರಿಗೆ ಹೆಚ್ಚಾಗಿ ಬಳಸುವ ಮೂಲಕ ವಾಯುಮಾಲಿನ್ಯ ನಿಯಂತ್ರಣಕ್ಕೆ ಸಹಕರಿಸೋಣ

ನಮ್ಮೆಲ್ಲರ ಚಿತ್ತ
ನೈಸರ್ಗಿಕ ಸಂಪನ್ಮೂಲಗಳ
ಮಿತ ಬಳಕೆಯತ್ತವಿರಲಿ

ಸಾರ್ವಜನಿಕರ ಹಿತಾಸಕ್ತಿಯಿಂದ ಪ್ರಕಟಿತ

ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮಾಲಿನ್ಯ ನಿಯಂತ್ರಣ ಮಂಡಳಿ

#49, ಪರಿಸರ ಭವನ, ಚರ್ಚ್ ಸ್ಟ್ರೀಟ್, ಬೆಂಗಳೂರು – 560 001 ದೂ: 080–2558 6520 / 2558 9112 / 2558 8142 ಫ್ಯಾಕ್ಸ್: 080–2558 6321
ಇಮೇಲ್ : ho@kspcb.gov.in ವೆಬ್‌ಸೈಟ್ : www.kspcb.gov.in

75 Students' Satellites Mission

ITCA's Engineering Prowess and Ingenuity

INDIAN TECHNOLOGY CONGRESS ASSOCIATION

ITCA Connecting Academia to Innovation in NewSpace through Development and Launch of Student-built CubeSats

ITCA's AI Creation