WORLD CANSAT/ROCKETRY CHAMPIONSHIP

INTERNATIONAL WEBINAR REPORT

22-26 June 2020

Flip Book Publication Team:

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World CanSat/Rocketry Championship 2021- Phase 0

International Webinar

Preamble

Every nation, be it a small or big, aspires to launch their own satellite to space and wishes to provide an opportunity to their scientists/students, in order to encourage them to continue space research. For the majority of the nations and academic institutions/universities, it is still a distant dream! Including former Yugoslavian Countries (Bosnia and Herzegovina, Macedonia, Montenegro, Croatia, Serbia and Slovenia). Committee for Space Programme Development (CSPD), Serbia, has been striving hard to provide an opportunity for building and launching satellites for former Yugoslavian countries. In continuation of their sustained efforts since last 2-3 years, CSPD has succeeded in establishing a working relationship with India and paved the way for Indo-Serbian Collaborative Research leading to the realisation of the launching of satellites of small nations. To realize the dream of launching nanosatellites to Low Earth Orbit (LEO), a systematic organic approach has been adopted in creating, sustaining the interest of space science and engineering education from schools to higher education eco system through such CanSat/Rocketry Competitions, CubeSat Workshops, Seminars etc, since last 3-4 years at various countries in general and Serbia/India in particular. CSPD, Serbia has conducted International CanSat/Rocketry Competition during Oct 2019 at Serbia and 5 Teams from India have participated among other countries! Mr. Dusan, Head, CSPD has visited India for an International Conference and signed an MoU with Indian Technology Congress Association (ITCA) for conducting World CanSat/Rocketry Championship and negotiations with likeminded Countries/Organisations have been initiated.

Background

INDIA
1st International Conference on Small Satellites- September 2018 by ITCA
2nd International Conference on Small Satellites- December 2018 by ITCA
UNISEC INDIA Chapter was Formed
Indo-Israel SpaceTech Leadership Delegation May 2018 by ITCA
3rd International Conference on Small Satellites- September 2019 by ITCA
Indo-Israel SpaceTech Leadership Delegation April 2019 by ITCA
International Samara Summer Space School at Russia; Attended by 5 Members from India in May 2019
International CanSat/Rocketry Competition, held at Serbia-October 2019. 5 Teams from India have Participated and Won 1st & 2nd Places
COSPAR UNOOSA Programme at Tel Aviv University, Israel; Attended by 5 Members from India in November-December 2019

SERBIA
Signed MoU with IfES/Wakayama University, Japan Regarding UNIFORM Project - September 2013
Started development of WQM-HUMSAT SYSTEM - December 2013
Participation in CLTP7 (Hokkaido University, Sapporo, Japan) – October 2016
The WQM SYSTEM ready for connection with IRIDIUM CONSTELATION - October 2017
UNISEC GLOBAL POC IN SERBIA - June 2018
The Contract of Bergamo signed (FEES Project) - August 2018
Organised International CanSat/Rocketry Competition, held at Serbia-October 2019. 45 Teams from Various Countries including India have Participated under CanSat/Rocketry Competitions
Mr. Dusan, Head, CSPD has visited India and Signed MoU with ITCA for Indo-Serbia Collaborative Initiatives during December 2019 in Bangalore, INDIA

Indo-Serbia Collaborative MoU Has been Signed and More Countries have shown Interest for World CanSat/Rocketry Championship has been Initiated

FOUNDING COUNTRIES

Serbia, India, Italy, Canada, Peru, Tunisia, Portugal

INTERCONTINENTAL AEROSPACE COMMAND

Due to the growing need for global coverage of reliable antenna networks for communication with satellites, Serbian, Indian, Italian, Russian*, Hungarian*, Canadian, Peruvian, Argentinean* and Australian* partners agreed to establish an *Intercontinental Aerospace Command* (hereinafter: **ICAS Command**).

The program holder is *Committee for Space Programme Development* (hereinafter: CSPD) (a formal headquarters is in Novi Sad), the existence of the **ICAS Command** has the following reasons:

- reliable global coverage (real-time communication, regardless of the position of the satellite);
- support and strengthening of SATNOGS network;
- raising radio amateurism to a higher level;
- gaining importance of the operators/owners/participating countries;
- global benefit;
- a global player;
- cooperation (unity) and assistance (help);
- motivation of young people for this area, etc.

The goal of the **ICAS Command** is that certain numbers of antennas become of greater global importance, and that their functionality be constantly reliable (as well as strengthening of SATNOGS network since all Antennas are at the same time and part of SATNOGS).

The **ICAS Command** functions according to the principle of rotating the chairperson, i.e. on every 3 months other operator/owner/country is chaired.

In essence, we also want to contribute to strengthening and expanding the SATNOGS network, as well as increasing its reliability for the benefit of all. We believe that SATNOGS is an idea of noble, wide and that must be supported and that everything necessary for SATNOGS survival must be done.

Status:

Active Ground Stations and connected to SATNOGS: Serbia, Italy, India, Canada
Ground Stations under construction: Peru, Russia, Argentina, Australia

1. INTRODUCTION

A **World CanSat/Rocketry Championship (**hereinafter: **WCRC)** is generally an international competition open to elite competitors from around the world, representing their nations (as university student Teams or as independent student Teams), and winning this event will be considered the highest or near highest achievement in this field.

After holding *the International CanSat/Rocketry Competition* in Serbia in October 2019, as a pilot project, Serbia and India agreed to launch the initiative to establish CanSat/Rocketry Championship at the Global level, so that the CanSat/Rocketry program can be raised to a higher level, involving even more students and countries, i.e. to make this program got a place in the World that deserves, because there is a lot to be learned through it. Both countries believe that this is very important globally, primarily in terms of education, and in promoting Space engineering in general.

The **WCRC** was formulated and negotiated among the Organizations from 6 countries: Serbia, India, Italy, Tunisia, Canada and Peru (hereinafter: **Founders**) from October 2019 to January 2020 and they agreed on the aims, structure and functioning of the **WCRC**.

This event is important for everyone, and for each founder country and for organizations, institutions and companies, and most important for education and students because the CanSat/Rocketry program is a vertical type of education compared to the horizontal they have in their studies.

2. BACKGROUND

What is a CanSat?

A CanSat is a simulation of a real satellite. All components are housed inside a can up to 350 ml. CanSat provides an affordable way to gain basic knowledge and skills in Space engineering for teachers and students, as well as experience engineering challenges when designing Satellites. Students are able to design and build a small electronic payload that can fit into the cans to 350 ml. CanSat is launched by Rocket, Balloon, Plane or Drone and delivered in apogee. With the Parachute, the CanSat slowly descends to the ground and carries out its mission during descent (for example: measures air pressure and temperature and sends telemetry). By analyzing the data collected by CanSat, students will explore the reasons for the success or failure of its mission.

Space engineering learning, based on the CanSat/Rocketry concept, enables students to gain hands-on experience through a specific interdisciplinary project. Since this is a Space engineering project, teachers and students will gain experience from mission defining, conceptual design, through integration and testing, to launching and actual system operation, i.e. experience from the whole Space project cycle and then participate in the CanSat/Rocketry competition with their peers at home country and abroad. One of the main advantages of the CanSat/Rocketry concept is its interdisciplinary: combination of mathematics, physics, informatics/programming, mechatronics, telecommunications, aviation and rocketry, mechanics, etc. CanSat is a simulation of a real, large, Satellite and contains all the components as a real Satellite, but with limited complexity.

Benefits of CanSat/Rocketry Based Education:

CanSat/Rocketry is an effective educational tool for:

- Learning by doing;
- Involving students in technology and engineering as a practical complement to other, fundamental, subjects they study, such as mathematics and physics;
- Emphasizing teamwork where each student has a specific task/role that creates a sense of responsibility for him/her;
- Students gain experience of the complete process: defining the mission, design, development/constructing, programming, testing, launching and analysis;
- Conducting simple experiments with balloon/rocket/plane/drone;
- Learning methods can be adapted to the age level of students, or to their needs and abilities;
- Students are able to analyze the reasons for success or failure after descending CanSat and Rocket to the ground;
- Acquired knowledge and experience can be applied to other projects as this concept enables obtaining of ideas and stimulates students' thinking;
- Useful for a further education/career guidance process;
- Provide Opportunities and Network for Launching their Own Small Satellites (Pico/Nano Satellites/PocketQube/ UNITYsat) to Low earth Orbit in a frugal way!
- Provide Opportunities and Network for Sharing and Learning from each other teams from various countries.

  Today, almost every country in the higher education system has a CanSat program, so the initiative to establish CanSat/Rocketry Championship at the Global level is additionally justified.

4. COMMON RULES

a) India will be the organizer and host of the CanSat/Rocketry Competition for Asian and Australian Continents, as Qualification for World Finals. Which means that India sets all rules for organizing and holding the Competition (Competition propositions, number of Teams, Teams rules in general, participation fee, place, date, rules on site etc.).

b) Italy and Serbia will organize together Competition for European Continent, as qualification for World Finals. Which means that Italy and Serbia set all rules for organizing and holding the Competition (Competition propositions, number of Teams, Teams rules in general, participation fee, place, date, rules on site etc.). The Competition will take place in Italy.

c) Tunisia will be the organizer and host of the Competition for African Continent and the Middle East, as qualification for World Finals. Which means that Tunisia sets all rules for organizing and holding the Competition (Competition propositions, number of Teams, Teams rules in general, participation fee, place, date, rules on site etc.).

d) Canada will be the organizer and host of the Competition for North American Continent, as qualification for World Finals. Which means that Canada sets all rules for organizing and holding the Competition (Competition propositions, number of Teams, Teams rules in general, participation fee, place, date, rules on site etc.).

e) Peru will be the organizer and host of the Competition for South American Continent, as qualification for World Finals. Which means that Peru sets all rules for organizing and holding the Competition (Competition propositions, number of Teams, Teams rules in general, participation fee, place, date, rules on site etc.).

f) Portugal and Serbia will organize together Competition for World Finals. Which means that Serbia and Portugal set all rules for organizing and holding the Competition based on its capacities and capabilities, and by adhering to a common document (*The basic rules for World Finals*). The Competition will take place one year in Serbia and second year in Portugal.

With the understanding that each founder country in particular is best aware of the situation on its continent and its own capacities and capabilities, this kind of independence in decision making and organizing is the best solution, with of course continuous mutual cooperation.

All founder countries have the adequate experience and the infrastructure, the necessary knowledge and skills. All founder countries will together define: *The basic rules of the qualification Competitions* and all other details for the World Finals (*The basic rules for World Finals*) as separate documents which will change every year for the purpose of development and progress. When participating in the final Competition in Serbia the Teams from India, Tunisia, Italy, Canada and Peru will have a special status, which includes lower costs and participation in the jury for representatives of the country. Founder countries may propose and agree on additional benefits related to World Finals at any time. Founder countries may propose and agree on anything which is important for constant improvement of the Championship, cooperation and this field in general, at any time. Voting is by simple majority.

Each founder country is responsible for its Continent and the Organization of the Competition and has the opportunity, if it wishes, to organize the Competition on its continent and with another country from the same continent and on the soil of that country. So, the Competition may not always be in the same country, but the founder country from that continent must be co-organizer with another country on which the Competition is organized.

The responsibility of each founder country is to promote, organize and hold the Competition on its continent by the end of the current year, the World Finals will be held always next year.

More precisely, to invite all students from their Continents to the Competition, to find the adequate place for this event (outdoor and indoor), to decide what they will use for Launch (Rocket or Balloon or Drone or Plane) and provide launch permissions (if required) and safety measures, related equipment, staff and everything else that is necessary to hold the event safe and successful. All founder countries should assist one another in all these processes.

Material for CanSat assembling is set by India and will be placed on Amazon for sale. Also, all Video Manuals and Handbooks are prepared by India and will be available to every country. Launch equipment (Rocket or Balloon or Drone or Plane) is on each founder country. Each founder country has the right to make a surplus or profit from the event and has the right to use **WCRC** for its own promotion.

Each year all founder countries will agree on the basic rules (primarily for: **FLIGHT MISSION**), as a separate document (*The basic rules of the qualification Competitions*), for qualifying Competitions across continents, with the **aim** of making the Competitions as similar as possible to all participants Worldwide. Each founder country may make certain changes to these basic rules for the purposes of its Competition only if such changes will improve the Competition itself and will not deviate much from the mentioned **aim**.

Each founder country has the same status in this project. All founder countries are completely equal, therefore, all founder countries have the same rights and obligations and that makes **WCRC** stronger, unique and successful. Between founder countries must be completely openness and honesty in communication and cooperation. Also, it is necessary that every country makes efforts to create a sustainable beautiful and perspective atmosphere.

5. CHAMPIONSHIP PHASES

The **WCRC** consists of 3 phases:

1. Phase 1 – **National CanSat/Rocketry Competition** as qualification for **Continental CanSat/Rocketry Competition**.
   In this Competition student Teams participate across their own state. If the state does not have a National Competition, then all student Teams can directly participate in the **Continental CanSat/Rocketry Competition** (i.e. Phase 2).
2. Phase 2 – **Continental CanSat/Rocketry Competition** as qualification for World Finals (Based on document: *The basic rules of the qualification Competitions*)
3. Phase 3 – **World Finals CanSat/Rocketry Competition**
   (Based on document: *The basic rules for World Finals*)

6. EVALUATION AND SCORING IN CHAMPIONSHIP PHASES 2 AND 3

6.1 The Jury

The Jury, appointed by founder countries, will be comprised of CanSat Experts, Education Experts, Engineers and Scientists who will evaluate the Teams' Performances during **Phases 2 and 3**.

The Jury will typically have 3-5 members, and their fields of expertise can vary from science to engineering or education. The Jury board will be usually comprised of:

- Space Science/Engineering Expert
- IT/Electronics Expert
- Education Expert
- Radio Communication Expert
- Rocketry Expert

6.2 Scoring

Performance in the following areas will be evaluated during **Phases 2 and 3**:

A. Technical Achievement

The Jury will take into account how the Teams obtained the results, how reliable and robust the CanSat was, visual appearance and how the CanSat performed. Innovative aspects of the project will be judged (e.g. the tools selected and the hardware/software used).

The aspects evaluated will be:
- Mission's Technical Complexity,
- Performance of the Mission.

B. Scientific value

The scientific value of the Teams' missions and the Teams' scientific skills will be evaluated. This includes the scientific relevance of the mission, the quality of the technical reporting (both written and oral) and the Team's scientific understanding that will be assessed from the Team's ability to analyze and interpret results appropriately.

The aspects evaluated will be:
- Scientific relevance,
- Scientific understanding,
- Technical reporting.

C. Professional competencies

The Jury will assess the Team's collaboration and coordination, adaptability and communication skills.
The aspects evaluated will be:
- Teamwork,
- Adaptability,
- Communication.

D. Outreach

The Team will be rewarded with additional points based on explanation: How the project is communicated to the local community, taking into account web pages, blogs, presentations, promotional material, media coverage etc.

6.3 Marking scheme

The overall balance between the items to be evaluated is as follows:

Technical Achievement 35%
Scientific Value 35%
Professional Competencies 20%
Outreach 10%

TOTAL 100%

6.4 Prizes for Phases 2 and 3

- 1st Prize
- 2nd Prize
- 3rd Prize

The following rule will apply:
- A Team can't receive more than one prize.

6.5 Quotas for World Finals

A total of 37 Teams can compete in the World Finals:
From Asian/Australian Continent 15 Teams
From African Continent 5 Teams
From North American Continent 5 Teams
From South American Continent 5 Teams
From European Continent 7 Teams
Each Team can consist of a minimum of 3 members and a maximum of 5 members.

The **World CanSat/Rocketry Championship (WCRC)** was formulated and negotiated among the Organizations from 6 countries: **Serbia, India, Italy, Tunisia, Canada** and **Peru**. Then, **Portugal** has been added. WCRC is open for adding many more countries in this process! This event is an international competition open to elite competitors from around the world, representing their nations (as university student Teams or as independent student Teams), and winning this event will be considered the highest or near highest achievement in this field!

Website: www.wcrc.world

This event is important as it boosts students in a vertical type of education as compared to horizontal. It aims to give an insight and build ambience of a practical space mission. The WCRC originally consists of 3 phases, hence, the formal inauguration of **International Webinar** has been marked as **Phase 0** held from **22-26 June 2020!**

Phase 0 - Online International Webinar + Quiz Assessment

Video 2020-06-15 to 2020-07-13 World CanSat & Rocketry Championship:

Video	Video Title	Video Publish Time	Views	Watch Time (hours)	Impressions
		Date/Total	8616	427.4617	23973
8psx5vsFwEc	Introduction to CubeSats	Jun 24, 2020	1681	62.7025	1651
vPqH0jucgXo	WCRC Inauguration - Phase 0	Jun 22, 2020	1536	59.0997	1878
wF-w3TZmrFQ	Official Introduction to World CanSat/Rocketry Championship	Jun 21, 2020	1065	18.5896	1399
9byaNtKHEag	About UNITY Program - A Cost Effective Frugal Innovative Way to Reach Orbit and Smartly with WCRC	Jun 25, 2020	921	34.7634	1345
58FTV8N91_8	What is a CanSat? Importance of Existence and Education	Jun 22, 2020	744	70.5977	1878
sQO45Cx_gEo	CanSat, A CubeSat learning kit Made in India [TSC]	Jun 23, 2020	473	47.3037	1557
-cJx7FrK9lg	About WCRC - Existence, Mission & Contest	Jun 22, 2020	435	19.5206	1671
Uke6YK-J4f8	Introduction to PocketQube	Jun 24, 2020	301	32.446	1499
5uuTMREtobM	WCRC Basic Rules- INDIA	Jun 23, 2020	287	6.1633	1359
n3W7bODee0Y	Organize Regional WCRC (Promoters)	Jun 26, 2020	230	8.5572	1410
9aUdDPiKN9E	Introduction to Amateur Radio, Ground Stations Systems and ICAS Command	Jun 25, 2020	213	19.8628	1516
aqEYwE4MGds	About Space Debris	Jun 26, 2020	188	28.7096	1292
rsm2gYCdywk	WCRC Basic Rules- ITALY	Jun 23, 2020	159	1.5806	1472
333cjgNfefM	Real Space Missions	Jun 26, 2020	142	11.6432	1342
UdM6kTgDyx4	WCRC Basic Rules- TUNISIA	Jun 23, 2020	123	2.9622	1265
muB5TVTA7bo	WCRC Basic Rules- PERU	Jun 23, 2020	83	2.6374	1283

Video 2020-06-15 to 2020-07-13 World CanSat & Rocketry Championship
Phase 0: International Webinar + Quiz Assessment

Sl. No.	Geography	Views	Watch Time (Hours)
	Total	**8623**	**427.6238**
1.	India	4661	194.2838
2.	Serbia	374	11.6329
3.	Colombia	276	38.2637
4.	Turkey	153	7.201
5.	Mexico	143	13.6103
6.	Japan	117	6.6791
7.	Germany	94	3.4771
8.	Lebanon	89	5.6248
9.	Egypt	69	1.6462
10.	Bahrain	61	8.377
11.	Peru	61	8.0418
12.	France	60	2.3527
13.	Russia	55	0.4178
14.	Philippines	52	1.6588
15.	United Kingdom	49	3.1913
16.	Algeria	49	1.2063
17.	Argentina	46	7.8581
18.	Portugal	44	2.9003
19.	Thailand	43	0.9169
20.	Brazil	39	0.8181
21.	Bangladesh	36	2.5298
22.	Rwanda	36	0.383
23.	Pakistan	36	0.0732
24.	Poland	34	0.6378
25.	Malaysia	34	0.628
26.	United States	33	1.9166
27.	Romania	32	3.7608
28.	Spain	32	0.609
29.	Ukraine	31	1.2864
30.	Chile	28	3.1044
31.	South Korea	25	1.8508
32.	Iraq	24	0.9021
33.	Tunisia	22	0.3537
34.	Indonesia	15	0.0408
35.	Vietnam	14	1.1498
36.	Uzbekistan	11	0.0155
37.	Angola	3	1.1554
38.	Others	37	0.629

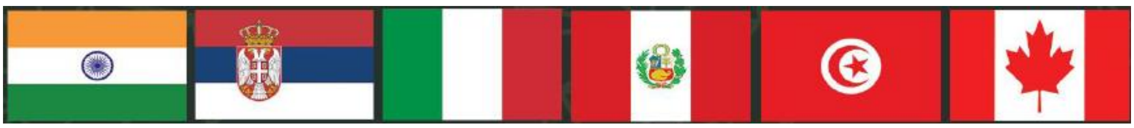
WCRC International Webinar-Phase 0: Promoters/Partners

World CanSat/Rocketry Championship (WCRC) – Phase 0

The Phase 0 of the WCRC objective is to help students around the world understand about Nanosatellites. This Phase has a series of Webinar and a bundle of fun quizzes. The adversity of the pandemic can be turned into an opportunity for the focused learning of satellites.

The webinar began from 22nd June, 2020 to 26th June, 2020. The webinar also provided information for others who wish to organise the National CanSat/Rocketry Competition or to be promoters of WCRC. The speakers of Webinar Series represented various countries. The diverse speakers covered a variety of topics in the field of Nanosatellites.

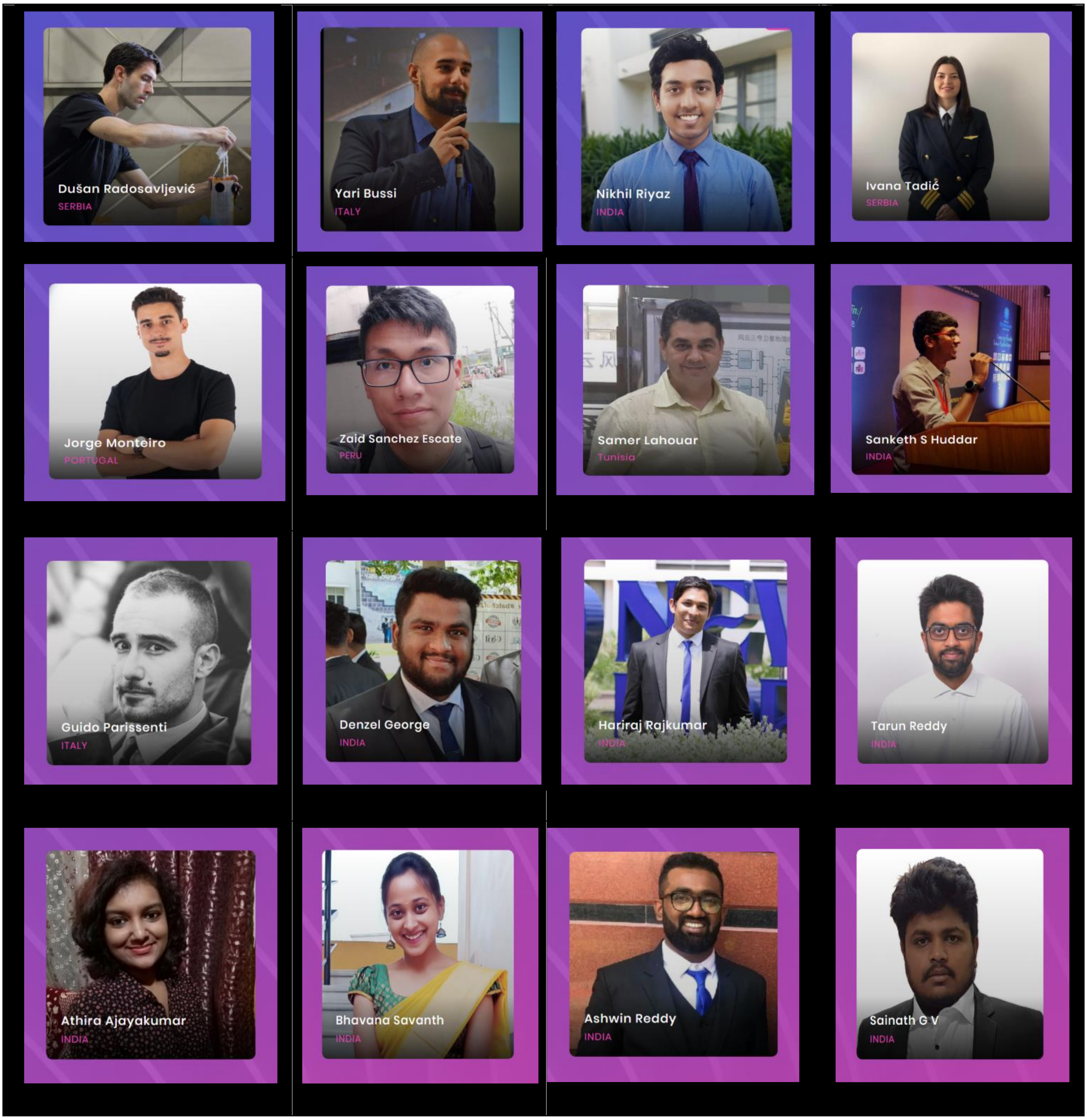
ORGANISATION	WEBSITE
Indian Technological Congress Association (ITCA), India	https://www.itca.org.in/
BRICS Federation of Engineering Organisations', Brazil, Russia, India, China and South Africa	https://infobrics.org/
Committee for Space Programme Development	http://2comnet.info/
UNISEC (University Space Engineering Consortium) Global	http://www.unisec-global.org/
NHCE MHRD Institutions' Innovation Council, India	https://www.mic.gov.in/iic.php
National Design and Research Forum (NDRF), India	https://www.ndrf.res.in/
Engineers Without Borders	http://ewb-international.com/
TSC Technologies Private Limited, India	https://tsctech.in/
GeekSpace Labs	https://geekspace.in/



WCRC: International Webinar Speakers!

YouTube

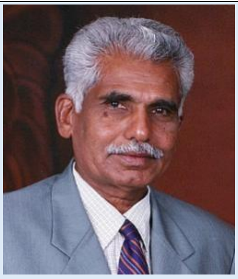
Visit: *WCRC.WORLD*



WCRC
WORLD CANSAT & ROCKETRY CHAMPIONSHIP

WORLD CANSAT ROCKETRY CHAMPIONSHIP

Best Wishes from Mentors and Advisors for TSC Technologies Private Limited for Initiating Wold CanSat/Rocketry Championship (WCRC)

	***Padma Shri. Prof. R. M. Vasagam***, *Former Project Director,* *India's First Geo Stationary Communication Satellite "APPLE",* *Eminent Scientist, ISRO,* *Former Vice Chancellor,* *Anna University*		***Padma Shri. Dr Y. S. Rajan***, *Honorary Distinguished Professor and Scientist, ISRO,* *Former Vice Chancellor,* *Punjab Technical University,* *Author of INDIA 2020: A Vision for New Millennium along with Dr.APJ. Abdul Kalam,* *Former President of India*
	***Padma Shri.*** ***Dr Mylswamy Annadurai***, *Outstanding Scientist, ISRO,* *Former Director, ISRO Satellite Centre,* *Project Director, Chandrayaan1 & 2 and Mangalyaan (Mars Orbiter Mission),* *Chairman,* *National Design and Research Forum*		***Dr. L. V. Muralikrishna Reddy*** *President,* *Indian Technology Congress Association,* *President,* *BRICS Federation of Engineering Organisations and* *President, University Space Engineering Consortium-India*
	***Dušan Radosavljević,*** *Founder and Head,* *Committee for Space Programme Development (CSPD), Serbia* *Founder, World CanSat/Rocketry Championship,* *Advisor, TSC Technologies Private Limited*		***Dr. Wooday P. Krishna,*** *National President,* *Indian Institution of Production Engineers,* *Vice President, World Academy of Engineers* *Vice President, UNISEC India* *National Council Member,* *The Institution of Engineers (India)*
	***Dr. J. Ramkumar, PhD (IIT Madras).,*** *Professor, Department of Mechanical Engineering,* *Indian Institute of Technology (IIT)- Kanpur* *Chairman,* *Institution of Engineers (India)- Kanpur Chapter*		***Dr. V. Dillibabu,*** *President, Engineers Without Borders,* *Director,* *National Design and Research Forum* *Scientist, Gas Turbine Research Establishment, DRDO,* *Ministry of Defence, Government of India,*
	***Maria Tvardovskaya,*** *Russia/Europe,* *Head "Profi2profit Education Project"* *Head, Global Institute of Design,* *INNOPROM, Russia*		***Dr. K. Gopalakrishnan*** *Secretary General, ITCA and BRICS FEO,* *Convener,* *75 Students' Satellites Consortium* *Secretary General, UNISEC India and* *Professor and Dean (R&D),* *New Horizon College of Engineering*

List is Incomplete…

From New Horizon to Beyond Horizon:

Sky is not the Limit for TSC Technologies Private Limited!

Team TSC Technologies Pvt Ltd

WCRC
WORLD CANSAT & ROCKETRY CHAMPIONSHIP

WORLD CANSAT ROCKETRY CHAMPIONSHIP

WCRC: Highlights of Webinar Speakers!

Visit: ***WCRC.WORLD***

Official Introduction to World CanSat/Rocketry Championship *(Mr. Sanketh, GEEKSPACE, India)*

The Webinar series started off with the first ticket to enter the WCRC Championship, that is Phase 0. This video highlighted the mission and milestones of WCRC and of course, about WCRC. The presenter also revealed the official logo of WCRC. The founding countries of WCRC are - Serbia, India, Italy, Tunisia, Canada and Peru. The phases of the WCRC were mentioned, that is: *Phase 1 – National Competition; Phase 2 – Continental Competition; Phase 3 – Grand Finale Championship.* There was also an announcement of opportunity! If some universities/ industries/ activists want to organise a CanSat/Rocketry Competition in a Region, WCRC Secretariat will provide all the support to make sure the event happens!

What is a CanSat? Importance of Existence and Education *(Mr. Dusan, CSPD, Serbia)*

The presentation started with CanSat History, CanSat/Rocketry building and it covered the explanation of the advantages of building one for Space Engineering Learning. Then explained about Concept of Operations (CONOPS) which describes the mission operations from Idea to Launch. The CanSat Design, Ground Station and Rocket constraints were given in brief, that was a necessary element while building and launching a CanSat. Few payload components were also presented.

Next section covered the main subsystems and chassis structure of the CanSat. The presenter explained about Satellite and Data Management Subsystem, Power Supply Subsystem, Communication Subsystem, Satellite Attitude Control Subsystem, Satellite bus and finally about the Payload.

Then the CanSat Bus was briefed, keeping the model CanSat DHU. Critical points that are involved when building the CanSat CONOPS in Field/Outdoor and Indoor Operations were listed. Lastly, the presenter motivated the participants by manifesting his resources on Rocketry and The Journey of 2019 CanSat/Rocketry International Competition organized by CSPD.

About WCRC *(Mr. Dusan, CSPD, Serbia)*

The speaker has begun the presentation talking about how WCRC came into existence, and the motive behind it. After mentioning the founding countries, the benefits and the experience, the World Cansat/Rocketry Championship brings for a nation, institution, and a student is spoken about.

More detail is given upon the roles, responsibilities, of the founding countries and the common rules for the competition. It is also mentioned that, Material for CanSat Assembling (WCRC Standard) is set by India, and will be listed on Amazon for sale. All video manuals and handbooks are prepared by India and will be available for every country.

The following slides cover Championship phases in detail, succeeding which, a detailed explanation about the Jury, how the Evaluation and Scoring will take place, the marking scheme and also about the number of prizes. Lastly, the quotas for the World Finals is shown and spoken about.

Basic Rules of WCRC – *India, Italy, Peru and Tunisia*

A presentation of the Basic rules and Regulations for WCRC were made by representatives of 4 countries, India, Italy, Peru and Tunisia. Each of the videos contains a basic description of the hosts and a brief introduction about the country.

Following which, the representatives brief the Key Parameters like the mission objective, CanSat Technical Requirements, Evaluation and Scoring, and the Basic Rules for WCRC in their respective countries. Representative from Tunisia has also included the flow of the event in his presentation. However, a detailed list of all the Rules and Important Regulations to keep in mind during the participation will be shared at the time of the competition.

Each member country has an unique and wide range of expertise in the Space Sector, which has been shown in the presentations in short.

https://www.youtube.com/watch?v=5uuTMREtobM&t=113s **(INDIA)**
https://www.youtube.com/watch?v=rsm2gYCdywk **(ITALY)**
https://www.youtube.com/watch?v=muB5TVTA7bo **(PERU)**
https://www.youtube.com/watch?v=UdM6kTgDyx4 **(TUNISIA)**

WORLD CANSAT & ROCKETRY CHAMPIONSHIP

CanSat Kit Made in India *(Mr. Nikhil and Tarun, UNISEC India and TSC, India)*

The presentation starts with Nikhil describing the CanSat. He describes the different areas CanSats can be used. He also describes the objective, functionality, and the physical characteristics.

Further into the presentation Nikhil talks about the various subsystems present in the advanced CanSat kit (CanSat Model S) built by TSC.

Tarun takes over to explain the basic model (CanSat Model E) In detail. He lays emphasis on the simplicity of the kit. Giving users the ability to experiment with this kit without having deep knowledge in the working of electronic systems was the object with which this kit was designed.

Tarun later goes throws light on the different software development tools used to program the CanSat. He mentions that the design of the OBC is based on Arduino UNO which is among the top most used Arduino boards, giving users access to a plethora of online learning resources.

Introduction to PocketQube *(Mr. Denzel and Hariraj, TSC and ITCA, India)*

The presenters, Denzel George and Hariraj R, gave an overview of PocketQube. The main goal is to give an insight into how PocketQube has evolved and also to give a few technical pointers to take account into when developing one. The takeaway here is to give intuition on the basics of a PocketQube.

The presentation started with the miniaturizing of technologies in day-to-day life with respective to Satellites and it covered the explanation of the advantages of building one. Then the practical general, mechanical requirements and design constraints were given in brief, that was a necessary element while building a PocketQube. Some payload ideas were also presented.

The next section covered the popularity behind PocketQube. The main popular reasons were mentioned. Then the main subsystems of the PocketQube were explained in brief: On-Board Computer, Electrical Power System, Communication System. The Critical points that are involved when designing the Communication and Electrical Power systems were listed. Lastly, the Conclusion and Usages of the PocketQube was given.

Introduction to CubeSats *(Ms. Athira and Bhavana, TSC and L&T, India)*

The presenters, Athira and Bhavana, gave an overview of CubeSats. The main goal is to give an insight into how CubeSat has evolved and also to give a few technical pointers to take account into when developing one. The takeaway here is to give intuition on the basics of a CubeSat.

The presentation started with the evolution of satellites and the revolution that led to the birth of CubeSats. It covered the various space travellers that has pinned down their achievements in space history. Then the practical missions were given in brief, that was carried out by various CubeSats.

The next section covered the popularity behind CubeSats. The main popular reasons were mentioned. Then the main subsystems of the CubeSat were explained in brief: On-Board Computer, Electrical Power System, Communication System. The key factors that are involved when designing the systems were listed for each subsystem. Lastly, the overview of the CubeSat Design Process was given.

About UNITY Program *(Mr. Dusan, CSPD, Serbia)*

The UNITY program represents a response to the increasing need of individuals and groups for easier access to Space, in order to achieve sustainable progress in their work and development of this area. The presentation started with the identifying the problems that contribute to the need for such a program. The Unity program is based on CubeSat standards, primarily by dimensions and basic characteristics. The 3U POD deployer carries several small satellites (UNITYsat) which will be delivered in Orbit.

The next section covered the various requirements that are to be met when developing the UNITYsat. These requirements include factors such as the mechanical requirements, electrical requirements, operational and testing requirements. This section detailed how one can use this platform to develop their mission and realize it in a frugal and cost-effective manner in situations where funding sources are limited. It also provides an opportunity to develop multiple linked satellite systems without the large cost of developing full-scale nanosatellites. It concluded by highlighting the collaborative opportunities that are available through the UNITY program.

Ground Station – ICAS, SATNOGS *(Mr. Sainath, BRICS FEO, India)*

The current presentation is an introduction to Ground Station, ICAS Command and Amateur Radio. The speaker starts off by describing Amateur Radio and its applications. The Speaker, does a live demonstration on how they communicate using HAM Radio. Moving ahead, he talks about the applications in slightly more detail and how they can be beneficial apart from being just a hobby. He has also mentioned some software to track Satellites.

Later, he covers some basic topics about satellite communication, like the Principle of Satellite Communication, Footprint of a Satellite, and some orbits. He continues by speaking about the Intercontinental Aerospace Command(ICAS) in detail and its architecture. The presentation is concluded by discussing and showing the ICAS Ground Station Kit.

About Space Debris *(Mr. Jorge, SPACEWAY, Portugal)*

Since the beginning of space flight, the collision hazard in Earth orbit has increased as the number of artificial objects orbiting the Earth has grown. The presenter Jorge Monteiro gives an insight into the present situation of the orbital debris and assesses the hazard that this population of debris poses.

Active and passive debris removal. The presentation started with a 3Doverview of the stuff in space. How space debris has increased exponentially over the past two decades. Challenges with tracking debris to avoid collisions. Analysing density and mass distributions of orbital debris.

Further in the presentation, Jorge explains the impacts of space debris, the damages they cause like colliding with other satellites, uncontrolled re-entry, and how space surveillance and tracking (SST) monitors and analyses the trajectory of space objects to issuing adequate warnings in case of potential threats of collision.

Lastly concludes by giving an overview of mitigation and protection by passive or active debris removal, in-orbit servicing.

Real Space Mission *(Dr. Guido, GP Advanced Projects-FEES, Italy)*

The presenter, Guido Parissenti started by giving an introduction to why space is explored and a brief history of the early days of the space age. The main goal is to give an overview of the real space missions and how space explorations have an impact on our day to day lives.

He also gives an insight into how new space is movement is revolutionizing the space sector, how privatizing the space sector has pushed the industry to the brink of innovation making it faster, better, and cheaper access to space.

The presentation also covers the space environment and its effects on space systems, an overview of the CubeSats, and its subsystems.

Lastly, an insight into the GP Advanced Projects has been presented by Guido: How they are empowering and collaborating with universities and organizations to help non-space companies in entering the space field. And concludes with a brief introduction of GP Advanced projects soon to be launched Flexible Experimental Embedded Satellite.

Organise Regional WCRC *(Ms. Ivana, CSPD, Serbia)*

Ivana Tadić, a commercial pilot, who is a part of Committee for Space Programme Development, Serbia presents the opportunity to organize WCRC in the national and continental level.

She then mentions about the role of the host country in brief. A lot of detailed information is given as to which permissions need to be taken, and what kind of precautionary measures have to be taken.

A brief outline is given upon how the competition can be held, and what parts of the competition can be outdoors and what can be indoors with reference to the International competition held in Serbia in 2019. Following which, the speaker talks about the phases in a detailed manner, and also throws light upon the jury, evaluation scheme, and how people will be awarded. To wrap it up, anyone who wishes to be a host and organize the national and continental phases of WCRC, can get in touch with Committee for Space Programme Development (CSPD) at cspd.office@gmail.com

World CanSat/Rocketry Championship 2021

ANNOUNCEMENT OF OPPORTUNITY (AO)

We Solicit Expression of Interest (EoI) from Interested Universities/Industries/Activists passionate about Small Satellites/Space Programs for hosting National/Continental "CanSat/Rocketry Competitions" in their respective Regions/ Countries/Continents! All necessary support services and encouragement will be provided by WCRC Secretariat! Send Email directly to Mr. Dušan Radosavljević stating your interest and profile with experience in Small Satellites/Space related activities etc.

Name - Mr. Dušan Radosavljević

Email - cspd.office@gmail.com

Founding Countries/Many More Countries are Welcome!

Speakers: Sanketh S. Huddar (TSC)

Date: 21st June, 2020

YouTube: https://youtu.be/wF-w3TZmrFQ

Official Introduction to World CanSat/Rocketry Championship

The Webinar series started off with the first ticket to enter the WCRC Championship, that is Phase 0. This video highlighted the mission and milestones of WCRC and of course, about WCRC.

The presenter also revealed the official logo of WCRC.

The founding countries of WCRC are - Serbia, India, Italy, Tunisia, Canada and Peru. The phases of the WCRC were mentioned, that is:

Phase 1 – National Competition

Phase 2 – Continental Competition

Phase 3 – Grand Finale Championship

There was also an announcement of opportunity! If some universities/ industries/ activists want to organise a CanSat/Rocketry competition in a region, WCRC Secretariat will provide all the support to make sure the event happens!

WCRC Inauguration – Phase 0

Speakers: Dr.Mylswamy Annadurai, Mr. M.V Kannan, Padmashri Prof.R.M. Vasagam, Dr. V. Dillibabu Padmashri, Dr. Y.S. Rajan, Dr. L.V.Muralikrishna Reddy, Mr. Rajangam and Prof. Ramkumar J.

Date: 22nd June,2020

YouTube: https://youtu.be/vPqH0jucgXo

The following eminent personalities, who are known in the field of space and engineering, have inaugurated WCRC and has given their best wishes!

Dr.Mylswamy Annadurai – Former Director ISRO Satellite Centre, Project Director of India's First Moon mission "Chandrayaan 1 and 2", Programme Director of Mars Orbiter Mission "Mangalyaan", Chairman of National Design and Research Forum (NDRF)

M.V Kannan – General Secretary, Planet Aerospace (Association of 300+ Retired Scientists from ISRO)

Padmashri Prof.R.M. Vasagam – Project Director, APPLE – India's First Geostationary Communication Satellite

Dr. V. Dillibabu – Director of National Design Research and Forum.

Padmashri Dr. Y.S. Rajan – Honorary Distinguished Professor and Scientist, ISRO. Author of India 2020: A Vision for New Millenium along with Dr. APJ Abdul Kalam, Former President of India

Dr. L.V.Muralikrishna Reddy – President, BRICS Federation of Engineering Organisation, Indian Technology Congress Association, UNISEC – India

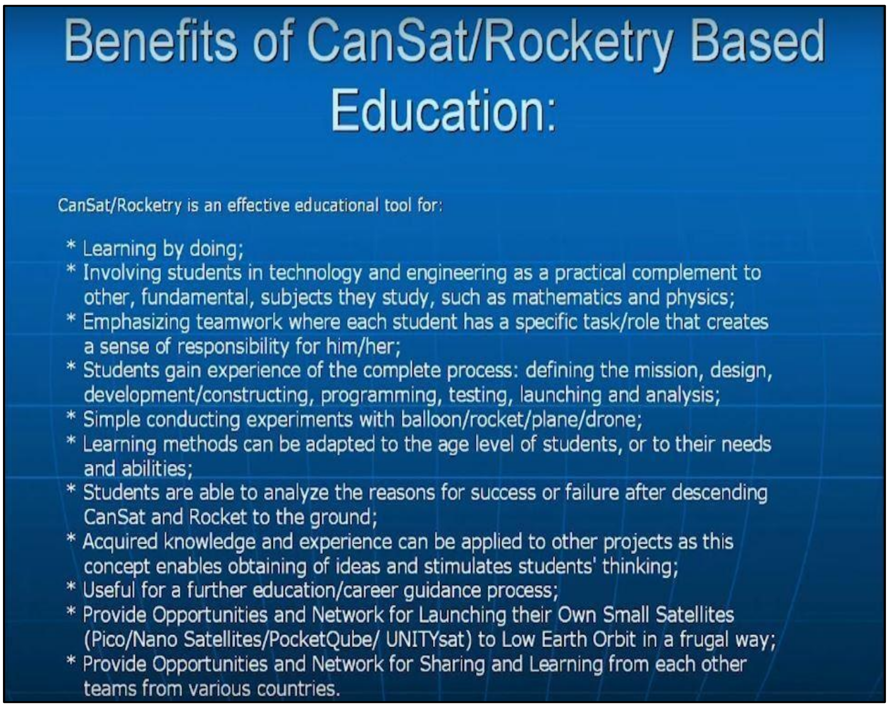
Mr. Rajangam – President, Planet Aerospace

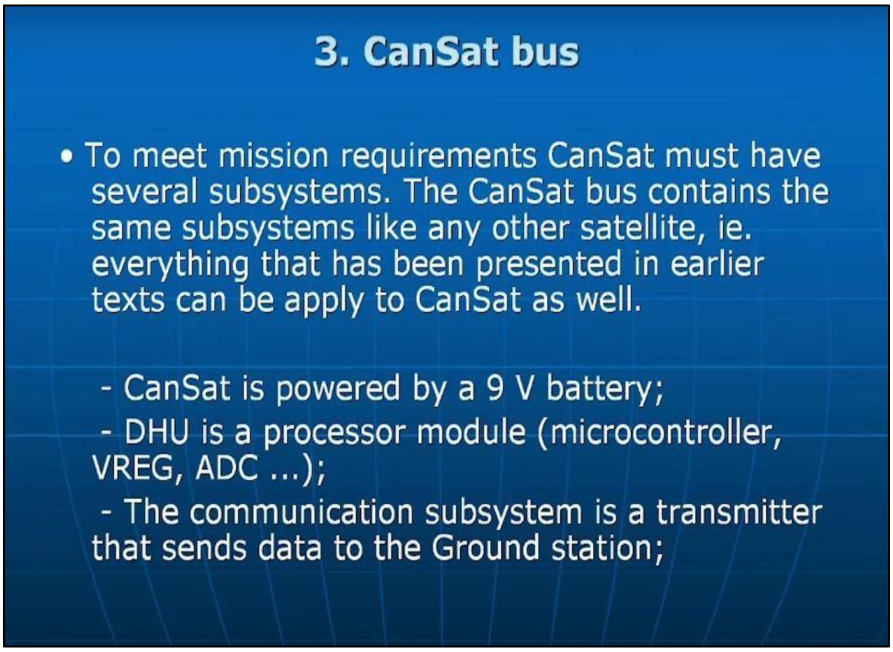
Prof. Ramkumar J. – Indian Institute of Technology, Kanpur

Speaker: Dušan Radosavljević / CSPD

Date: 22nd June, 2020

YouTube: https://youtu.be/58FTV8N91_8





What is a CanSat? Importance of Existence and Education

The presentation started with CanSat History, CanSat/Rocketry building and it covered the explanation of the advantages of building one for Space Engineering Learning. Then explained about Concept of Operations (CONOPS) which describes the mission operations from Idea to Launch. The CanSat Design, Ground Station and Rocket constraints were given in brief, that was a necessary element while building and launching a CanSat. Few payload components were also presented.

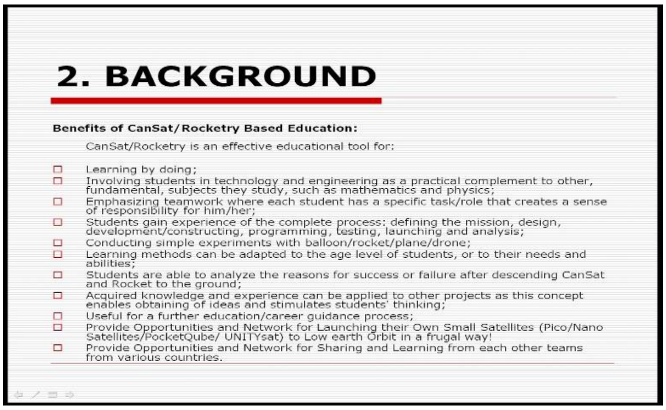
Next section covered the main subsystems and chassis structure of the CanSat. The presenter explained about Satellite and Data Management Subsystem, Power Supply Subsystem, Communication Subsystem, Satellite Attitude Control Subsystem, Satellite bus and finally about the Payload.

Then the CanSat Bus was briefed, keeping the model CanSat DHU. Critical points that are involved when building the CanSat CONOPS in Field/Outdoor and Indoor Operations were listed. Lastly, the presenter motivated the participants by manifesting his resources on Rocketry and The Journey of 2019 CanSat/Rocketry International Competition organized by CSPD.

Speakers: Dušan Radosavljević / CSPD

Date: 22nd June, 2020

YouTube: https://www.youtube.com/watch?v=-cJx7FrK9lg



About WCRC

The speaker has begun the presentation talking about how WCRC came into existence, and the motive behind it. After mentioning the founding countries, the benefits and the experience, the World Cansat/Rocketry Championship brings for a nation, institution, and a student is spoken about.

More detail is given upon the roles, responsibilities, of the founding countries and the common rules for the competition. It is also mentioned that, Material for CanSat Assembling (WCRC Standard) is set by India, and will be listed on Amazon for sale. All video manuals and handbooks are prepared by India and will be available for every country.

The following slides cover Championship phases in detail, succeeding which, a detailed explanation about the Jury, how the Evaluation and Scoring will take place, the marking scheme and also about the number of prizes. Lastly, the quotas for the World Finals is shown and spoken about.

Basic Rules of WCRC – India, Italy, Peru and Tunisia

A presentation of the Basic rules and Regulations for WCRC were made by representatives of 4 countries, India, Italy, Peru and Tunisia. Each of the videos contains a basic description of the hosts and a brief introduction about the country.

Following which, the representatives brief the Key Parameters like the mission objective, CanSat Technical Requirements, Evaluation and Scoring, and the Basic Rules for WCRC in their respective countries. Representative from Tunisia has also included the flow of the event in his presentation. However, a detailed list of all the Rules and Important Regulations to keep in mind during the participation will be shared at the time of the competition.

Each member country has an unique and wide range of expertise in the Space Sector, which has been shown in the presentations in short.

Speakers: Representatives from ***India, Italy, Tunisia*** and ***Peru***

Date: 23rd June, 2020

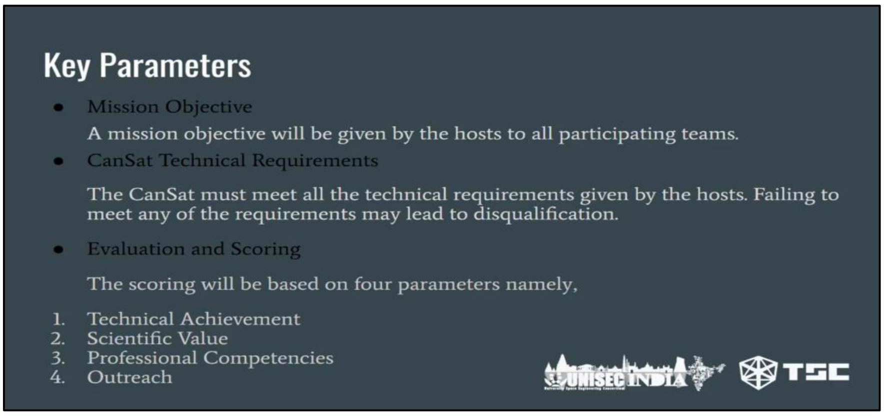
YouTube:

https://www.youtube.com/watch?v=5uuTMREtobM&t=113s (INDIA)

https://www.youtube.com/watch?v=rsm2gYCdywk (ITALY)

https://www.youtube.com/watch?v=muB5TVTA7bo (PERU)

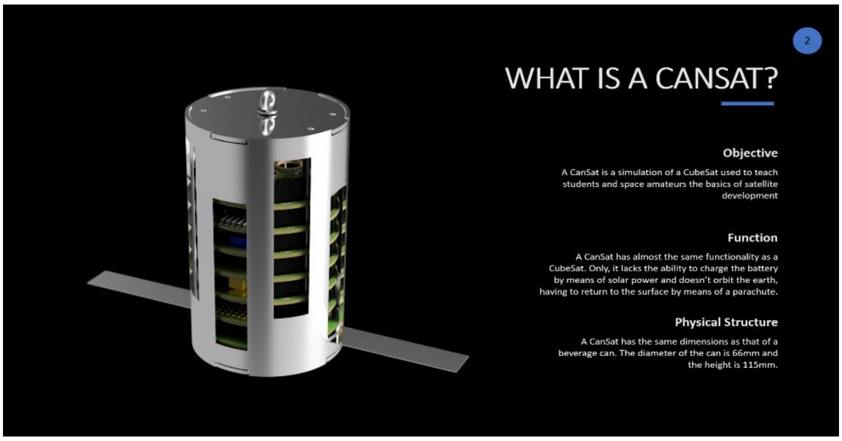
https://www.youtube.com/watch?v=UdM6kTgDyx4 (TUNISIA)

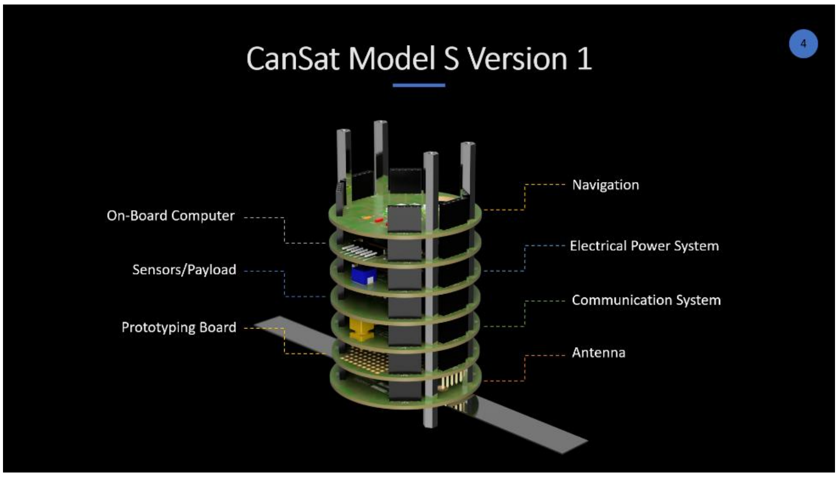


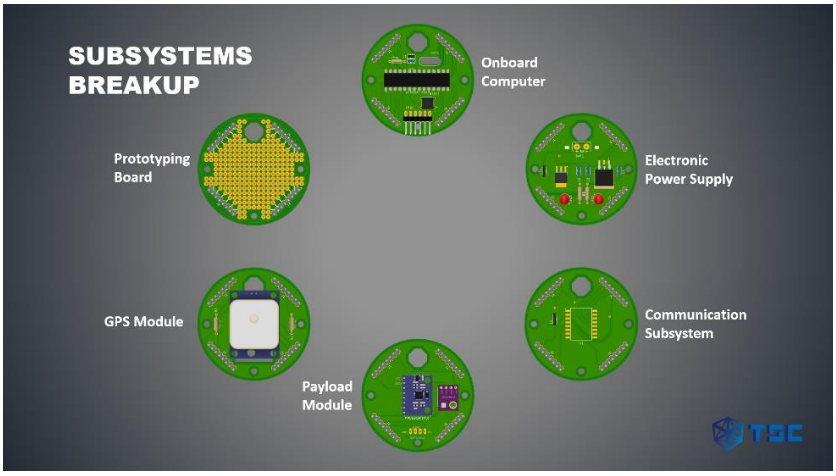
Speakers: Nikhil Riyaz /TSC and Tarun Sai Reddy/TSC

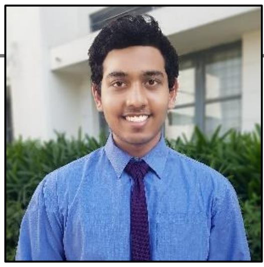
Date: 23rd June 2020

YouTube: https://www.youtube.com/watch?v=sQO45Cx_gEo









Nikhil

CanSat Kit Made in India

The presentation starts with Nikhil describing the CanSat. He describes the different areas CanSats can be used. He also describes the objective, functionality, and the physical characteristics.

Further into the presentation Nikhil talks about the various subsystems present in the advanced CanSat kit (CanSat Model S) built by TSC.

Tarun takes over to explain the basic model (CanSat Model E) In detail. He lays emphasis on the simplicity of the kit. Giving users the ability to experiment with this kit without having deep knowledge in the working of electronic systems was the object with which this kit was designed.

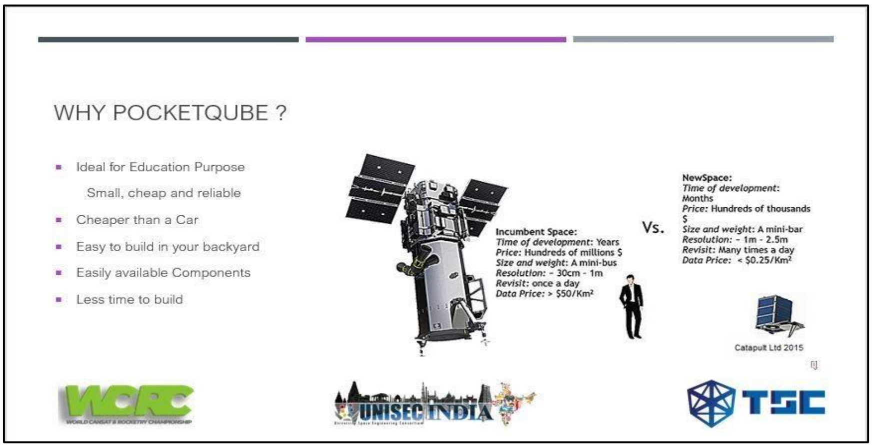
Tarun later goes throws light on the different software development tools used to program the CanSat. He mentions that the design of the OBC is based on Arduino UNO which is among the top most used Arduino boards, giving users access to a plethora of online learning resources.

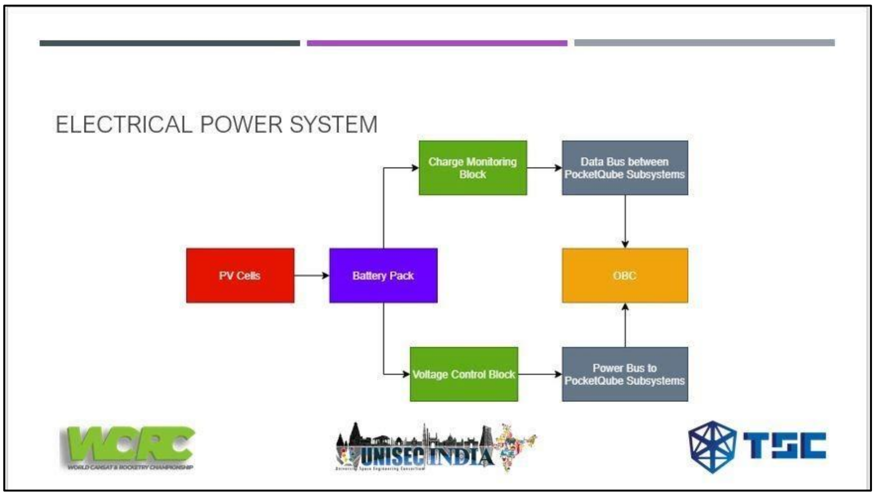
Tarun

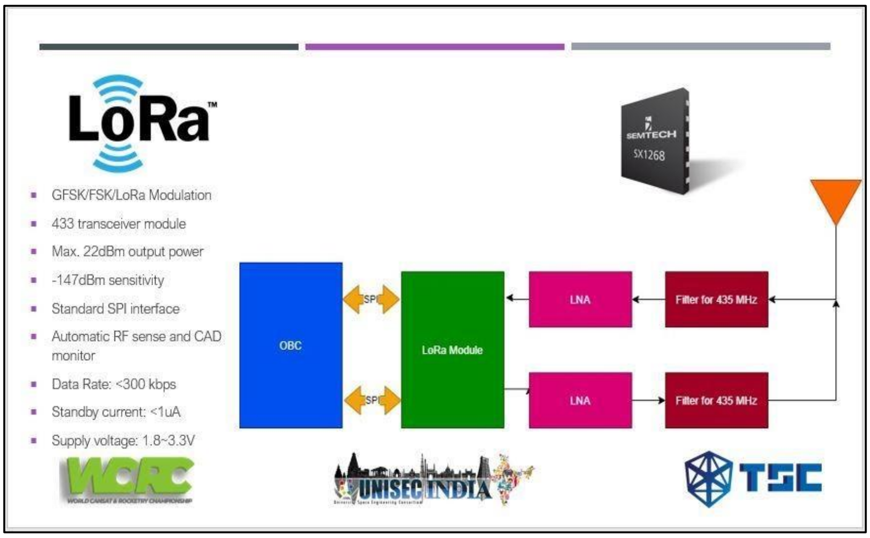
Speakers: Denzel George / TSC and Hariraj R / TSC

Date: 24th June 2020

YouTube: https://www.youtube.com/watch?v=Uke6YK-J4f8&t=1382s







Denzel

Introduction to PocketQube

The presenters, Denzel George and Hariraj R, gave an overview of PocketQube. The main goal is to give an insight into how PocketQube has evolved and also to give a few technical pointers to take account into when developing one. The takeaway here is to give intuition on the basics of a PocketQube.

The presentation started with the miniaturizing of technologies in day-to-day life with respective to Satellites and it covered the explanation of the advantages of building one. Then the practical general, mechanical requirements and design constraints were given in brief, that was a necessary element while building a PocketQube. Some payload ideas were also presented.

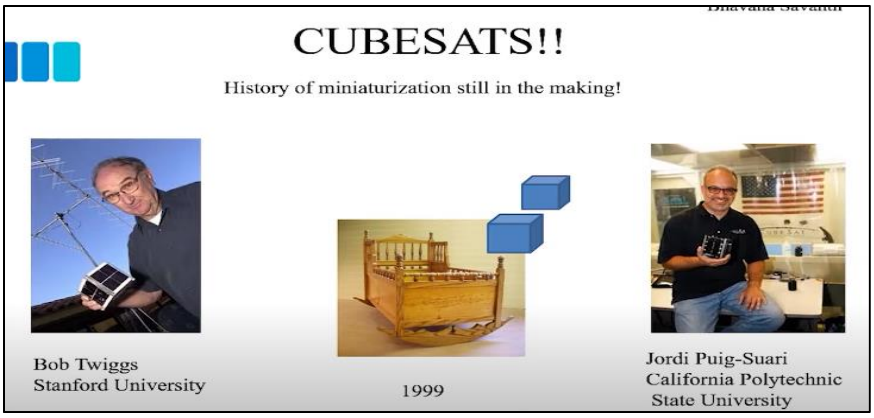
The next section covered the popularity behind PocketQube. The main popular reasons were mentioned. Then the main subsystems of the PocketQube were explained in brief: On-Board Computer, Electrical Power System, Communication System. The Critical points that are involved when designing the Communication and Electrical Power systems were listed. Lastly, the Conclusion and Usages of the PocektQube was given.

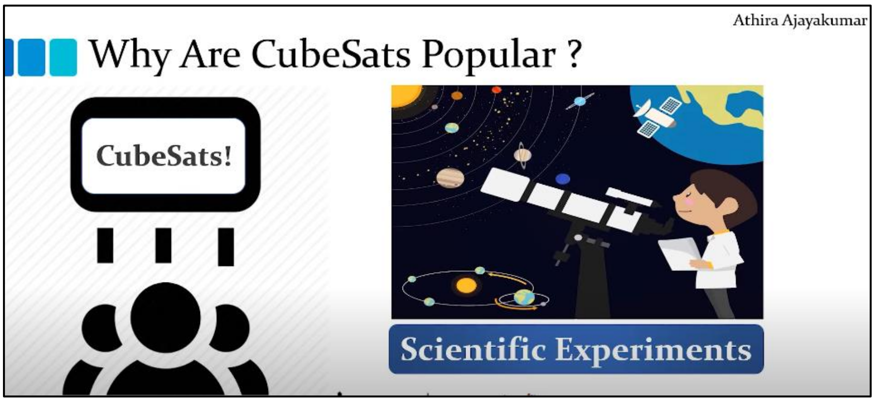
Hariraj

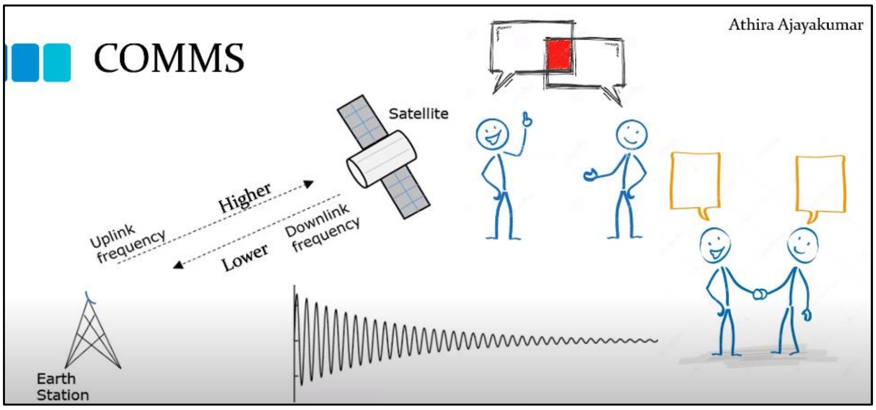
Speakers: Athira Ajayakumar /TSC and Bhavana Savanth /TSC

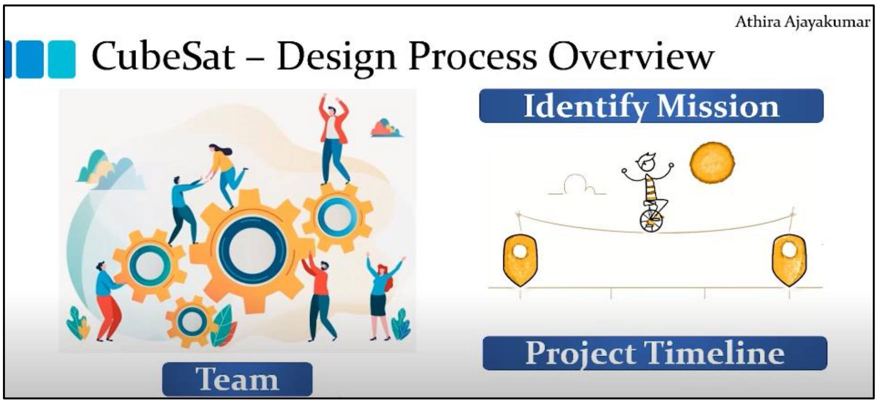
Date: 24TH June, 2020

YouTube: https://youtu.be/8psx5vsFwEc









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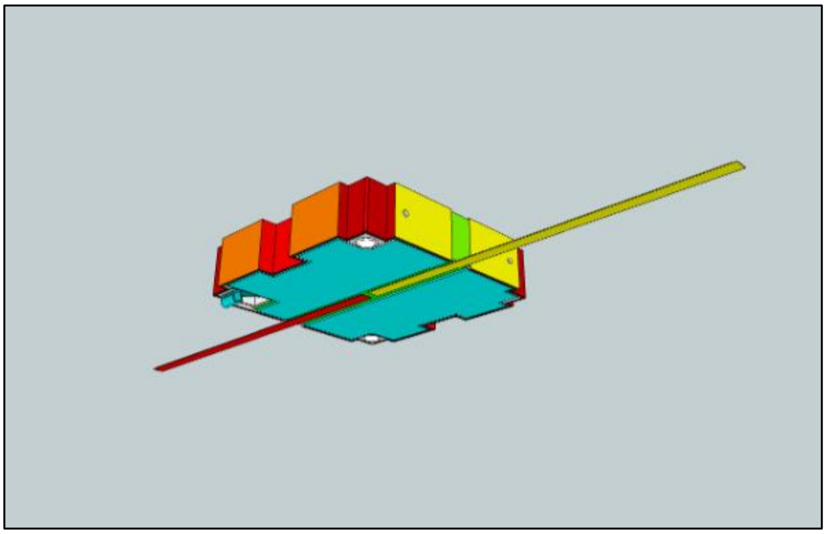
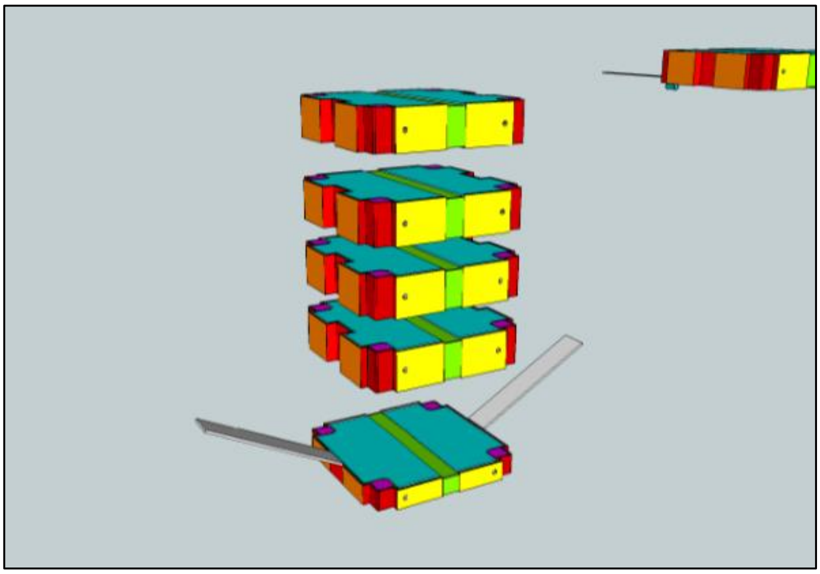
Bhavana

Speaker: Dusan Radosavljevic /CSPD

Date: 25^{TH} June, 2020

YouTube: https://youtu.be/9byaNtKHEag





About UNITY Program

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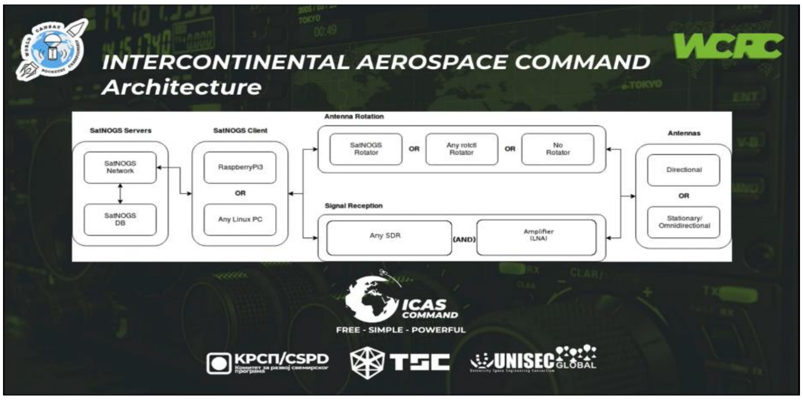
It concluded by highlighting the collaborative opportunities that are available through the UNITY program.

Ground Station – ICAS, SATNOGS

Speakers: Sainath Vamshi (VU3HJT) /TSC

Date: 25^{TH} June, 2020.

YouTube: https://www.youtube.com/watch?v=9aUdDPiKN9E&t=686s



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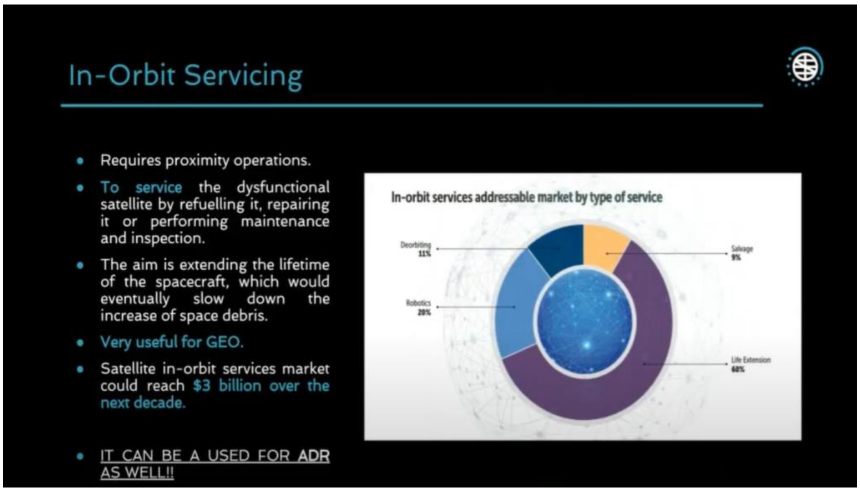
Speakers: Jorge Monteiro / Spaceway.pt

Date: 26th June, 2020

YouTube: https://www.youtube.com/watch?v=aqEYwE4MGds&t=1314s



About Space Debris

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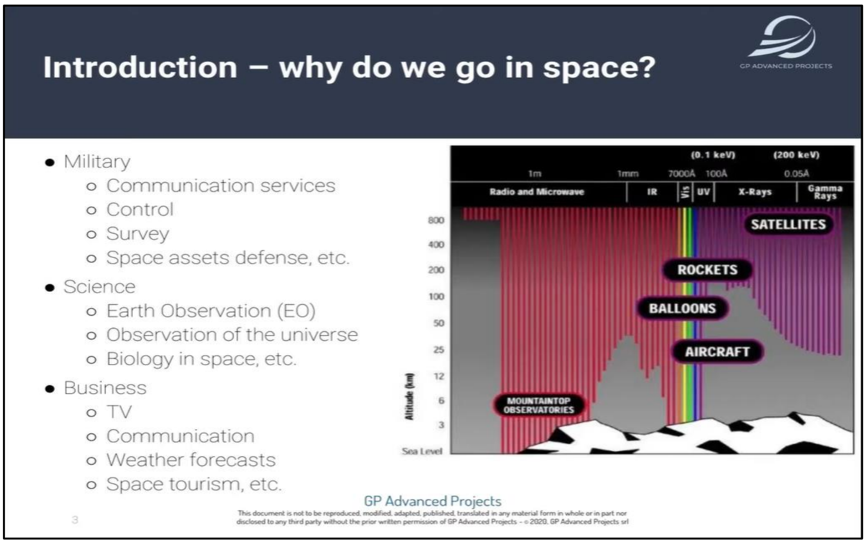
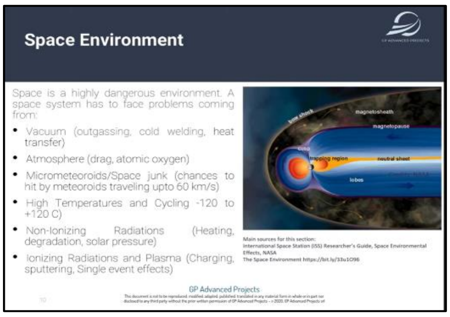
Lastly concludes by giving an overview of mitigation and protection by passive or active debris removal, in-orbit servicing.

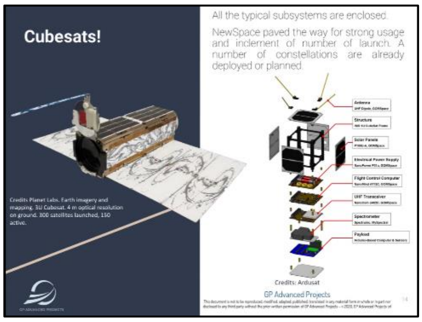
Speakers: Guido Parissenti / GP Advanced Project

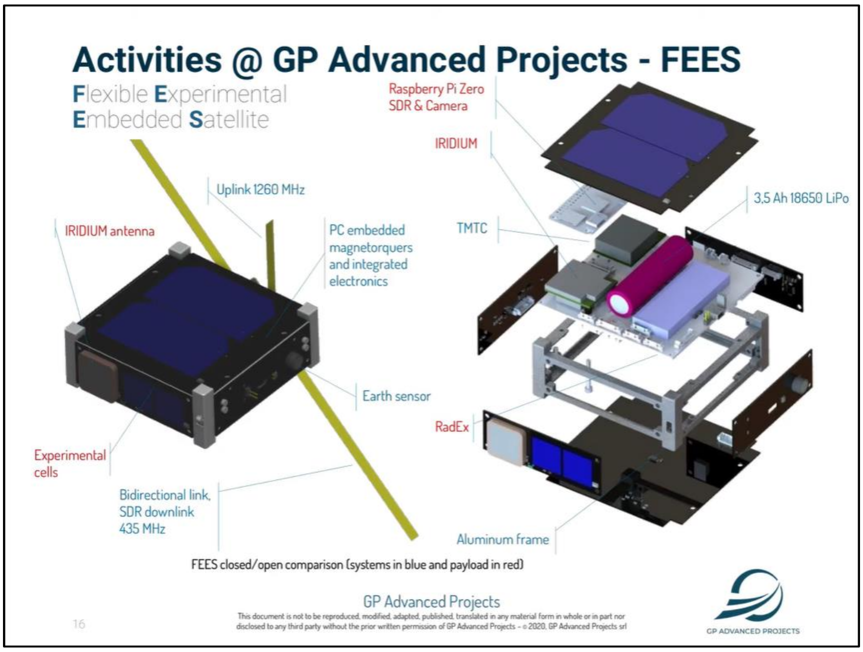
Date: 26TH June, 2020

YouTube: https://www.youtube.com/watch?v=333cjgNfefM&t=19s









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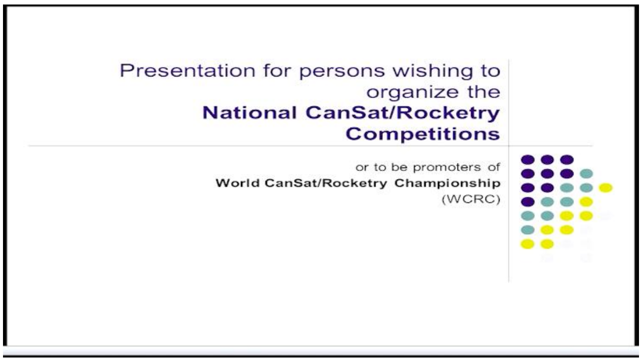
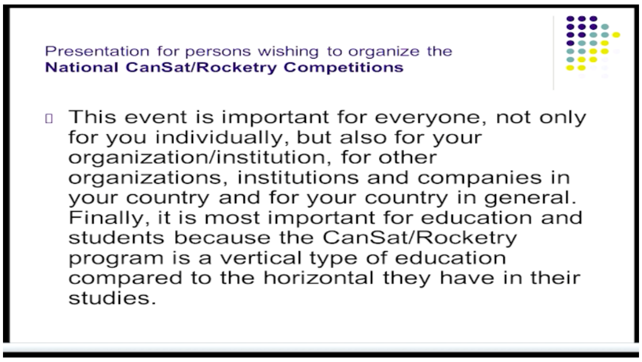
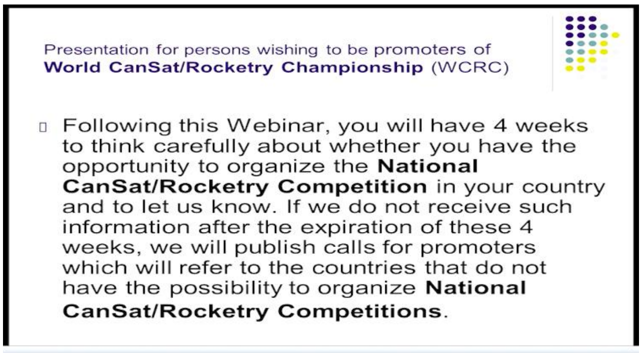
Speakers: Ivana Tadić /CSPD

Date: 26th June, 2020.

YouTube: https://www.youtube.com/watch?v=n3W7bODee0Y







Organise Regional WCRC

Ivana Tadić, a commercial pilot, who is a part of Committee for Space Programme Development, Serbia presents the opportunity to organize WCRC in the national and continental level.

She then mentions about the role of the host country in brief. A lot of detailed information is given as to which permissions need to be taken, and what kind of precautionary measures have to be taken.

A brief outline is given upon how the competition can be held, and what parts of the competition can be outdoors and what can be indoors with reference to the International competition held in Serbia in 2019. Following which, the speaker talks about the phases in a detailed manner, and also throws light upon the jury, evaluation scheme, and how people will be awarded. To wrap it up, anyone who wishes to be a host and organize the national and continental phases of WCRC, can get in touch with Committee for Space Programme Development (CSPD) at cspd.office@gmail.com

Era of Small Satellites: Pico, Nano and Micro Satellites (PNM Sat)-An Over View Frugal Way to Access Low Earth Orbit

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Abstract
Every nation, be it a small or big, aspires to launch their own satellite to space and wishes to provide an opportunity to their scientists/students, in order to encourage them to continue space research. For the majority of the nations and academic institutions/universities, it is still a distant dream! Including former Yugoslavian Countries *(Bosnia and Herzegovina, Macedonia, Montenegro, Croatia, Serbia and Slovenia)*. Committee for Space Programme Development (CSPD), Serbia, has been striving hard to provide an opportunity for building and launching satellites for former Yugoslavian countries. In continuation of their sustained efforts since last 2-3 years, CSPD has succeeded in establishing a working relationship with India and paved the way for Indo-Serbian Collaborative Research leading to the realisation of the launching of satellites of small nations. This paper highlights the opportunities opened up globally during Space 2.0 era and need for the Pico, Nano and Micro Satellites (PNM Sat) as a frugal way to access space and sustain space research by academic institutions and small nations to realize their dream in a more frugal way!

Keywords: Pico, Nano and Micro Satellites (PNM Sat), CanSat, PocketQube, CubeSat, UNITYsat

ACRONYMS AND ABBREVIATIONS

AA	*Aluminium alloy*	*LV*	*Launch vehicle*
AOCS	*Attitude and orbit control subsystem*	*LEO*	*Low Earth orbit*
ASD	*Acceleration spectral density*	*MoS*	*Margin of safety*
ATOX	*Atomic oxygen*	*MEO*	*Medium Earth orbit*
COM	*Communication subsystem*	*OBCS*	*On-board computer subsystem*
CoG	*Center of gravity*	*PA/QA*	*Product and Quality Assurance*
CoM	*Center of mass*	*PSD*	*Power spectral density*
EO	*Earth observation*	*PCB*	*Printed circuit board*
EPS	*Electric power subsystem*	*PDF*	*Probability density function*
E-sail	*Electric solar wind sail*	*PNMSat*	*PicoSat, NanoSat and Micro Sat*
EMC	*Electromagnetic compatibility*	*PR*	*Public relations*
ESD	*Electrostatic discharge*	*RBF*	*Remove Before Flight*
EM	*Engineering model*	*RF*	*Radio frequency*
ESA	*European Space Agency*	*RW*	*Reaction wheel*
FEA	*Finite element analysis*	*SDOF*	*Single-degree-of freedom*
FPGA	*Field-programmable gate array*	*SPL*	*Sound pressure level*
FH	*Flight hardware*	*SS*	*Stainless steel*
GEO	*Geosynchronous orbit*	*SSO*	*Sun Synchronous Orbit*
CG	*Gold gas*	*ST*	*Star tracker*
HW	*Hardware*	*STEM*	*Science, Technology, Engineering & Mathematics*
HS	*High-level sine*	*STR*	*Structure subsystem*
HSCOM	*High-speed communication*	*Ti*	*Titanium*
IFA	*Inverted-F antenna*	*UHF*	*Ultra-high frequency*
		VHF	*Very high frequency*

Introduction
The first man-made object that was launched into space was the Sputnik-1 satellite [1] in 1957. That was fascinating and appealing to all humankind and escalated the Space Race [2], consequently developing technologies and bringing attention to space science around the globe. Space became more accessible and open to not only governmental space agencies and huge companies but also universities and other educational institutions in recent years. Technologies and devices have a tendency of becoming smaller in size and more powerful in performance (an ideal example is the Smartphone industry). A similar development has occurred in small satellite design, they have decreased in size as well as became more of a standard in their build-up. This trend was introduced by the California Polytechnic State University and Stanford University as CubeSat in 1999.

> ***CubeSat*** *concept introduced by Bob Twiggs and Jordi Puig-Suari in 1999*
> - *small (10x10x10 cm, 1 kg – Picosatellite)*
> - *low cost*
> - *short development time*
> - *ideal for education*
> - *involvement in all phases of Space project*

Acknowledgement to NHCE Students' Satellite Team/Start-up TSC: ***We acknowledge the contributions of the Research Engineers of NHCE/TSC!***

Cube Satellite (CubeSat)

A CubeSat is a cubic-shaped satellite identified by the number of units. One unit, more commonly known as 1U, is a cube with a volume equivalent to one litre and a side-length of 10 cm. By merging a few cubes on top of each other, the variety of sizes increases (1U, 2U, 3U, 6U…). Satellites can be categorised by their mass. The one with a mass below 1 kg is a picosatellite, which is very often a 1U CubeSat (by default the mass of each unit should not exceed 1.33 kg), or a PocketQube (0.25U). The majority of the launched or built CubeSats are nanosatellites with a mass of 1-10 kg, shown in Figure 1, as per March 14th 2017 [3].

Majority of 3U CubeSats mentioned in Figure 1 below have a nominal mass limitation equivalent to 4 kg, however, depending on the deployer (mechanical interface between the CubeSat and the launch vehicle (LV)), the mass can be higher. As in the case of ISIPOD, the maximum allowable mass for 3U is 6 kg [4]. A spacecraft with a mass range from 10 to 100 kg is a microsatellite, below 1 kg a picosatellite, and below 0.1 kg a femtosatellite. The smallest publicly-known femtosatellite is called a KickSat, which is a 3.5 by 3.5 cm single printed circuit board (PCB) with a microprocessor, gyroscope, magnetometer, radio with antennas, and solar cells [5].

As with any piece of hardware (HW), a satellite needs a structure for holding it together or deploying into the orbit, even in the case of KickSat. Moreover, the development process for space structures is somewhat similar to the ground-application with more strict requirements and constraints.

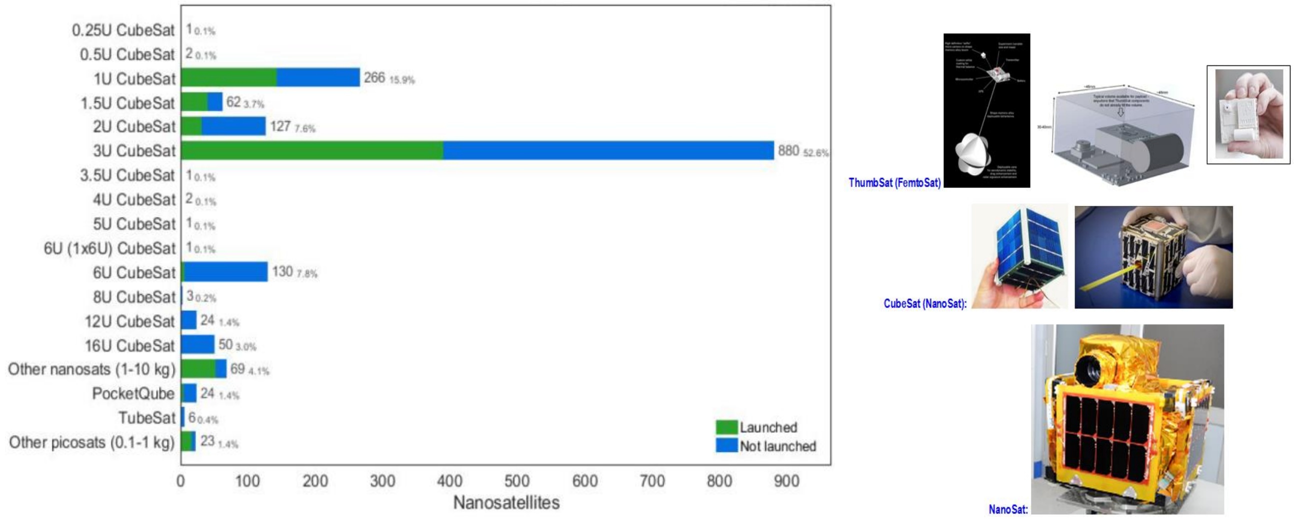


Figure 1. Nanosatellites by type

> ***Nanosatellites (NanoSat)***
> - *First CubeSats launched in early 2000*
> - *By now: > 800 nanosatellites launched*
> - *Record in 2017: 104 on a single PSLV launcher*
> - *Exponential increase in recent years*
> - *Standard deployers important*
> - *XPOD, P-POD, ISIPOD, Nanoracks (from ISS)*
> - *Standardized launcher interfaces*
> - *Initially mostly 1U, 2U, 3U CubeSats*
> - *Trend to larger nanosatellites 6U, 8U, 12U*
> - *Nanosatellite classification 1…10 kg mass*

Development process initiates with the list of requirements and ends up with the product delivering for LV integration; it consists of designing, verification, manufacturing, and testing. The design includes developing requirements, identifying options, doing analysis and trade studies, and defining a product in enough detail so one can build it or manufacture it[7, p.1]. For the ground applications, one also considers the outer appearance (how it looks like and how it feels like), however, for the space mission the main target in designing is functionality under certain requirements (some exceptions exists for public relations (PR) purposes). Hence, the structure has to be cost-effective which means obtaining high performance, reliability, and confidence for spent money, considering not only knowns but also variables and uncertainties [7, p.1].

In this particular case, the satellite consists of payloads (which conduct scientific and technologic demonstration and performance) and subsystems or satellite bus (which operates the spacecraft). The structure supports the payload and spacecraft subsystems with enough strength and stiffness to preclude any failure (rupture, collapse, or detrimental deformation) that may keep them from working successfully [7, p.23]. Key requirements consist of functional (what must be done), operational (how well it must be done), and constraints (limit the available sources, schedule, or physical characteristics) [7, p.26]. The risk has to be evaluated and if the elimination is not feasible due to constraints in terms of time, cost, or schedule shift, then one has to accept the certain probability of failure or damage. In addition, the level of risk has to be evaluated with its influence on the entire mission – will it cause full mission failure or just minor element deformation that does not affect the mission success. Any risk evaluation starts with the estimation of failure probability and resolving the consequences of that failure.

Space Mission Habitat

After the satellite reaches the specific orbit, it will be exposed to other harmful habitats in the near-Earth space environment. The list consists of, but is not limited to, vacuum, thermal radiation, charged-particles radiation, neutral atomic and molecular particles, micrometeorites and space debris, magnetic fields, and gravitational fields [7, p.61]. Various sources are influencing the man-made objects as a function of orbit (Figure 2), where LEO is a low Earth orbit (160-2000 km), MEO is a medium Earth orbit (2000-35000 km), and GEO is a geosynchronous orbit (35876 km).

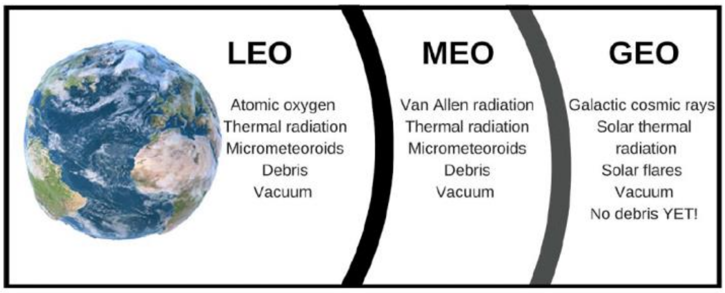


Figure 2. Space environment as the function of altitude

The term **vacuum** describes the extremely low pressure in space. A vacuum has various effects on the structure. In vacuum, polymer-based materials (thermal insulators, adhesives and the matrices for advanced composites) release substances in a gaseous form [7, p.63]. The substance is one of an organic origin or absorbed nitrogen, oxygen, and carbon dioxide on the ground. Moreover, the material has issues with water desorption that was absorbed by the material during on-ground processes. The aforementioned effects may degrade certain properties of the material and might cause condensation on critical surfaces (lenses, mirrors, and sensors). Another effect is the internal pressure of sealed structures that were assembled at the ambient Earth pressure.

Thermal radiation is mainly a reference to direct solar flux (1309-1400 W/m2) which means the intensity of radiation, planetary albedo (global annual average is 0.3) which originates from the reflected solar flux, planetary emission flux (189-262 W/m2), and the satellite electronics' infrared thermal emission. This results in non-uniform heating of spacecraft which causes materials (especially with various thermal expansion coefficients) to expand differently, resulting in structural stresses. In addition, certain components require a precise operating temperature range (e.g. batteries, propellant tanks). The solution is to implement an active (requires power) and/or a passive (materials and coatings) thermal control system.

Charged-particle radiation is a high flux of energetic particles. The major sources are trapped radiation (Van Allen belt) which contains electrons and protons in the MEO, galactic cosmic radiation which contains 90% of protons and 10% of helium nuclei in the GEO and further, and solar radiation which is largely continuous solar wind (electrons, protons, and helium nuclei low in energy) and solar flares (high energetic protons and heavy ions) [7, p.69]. The radiation has a negative effect on the electronic components and may cause damage or failure to the systems. There is no way to predict or to be protected against galactic cosmic radiation, thus electronics have to tolerate it.

Classification/Category of Satellites (Based on Weight)

a) Minisatellite (100–500 kg)
b) Microsatellite (10–100 kg)
c) Nanosatellites (1 -10 kg)
d) Picosatellites (100 gm-1 kg)
e) Femtosatellites (10-100 gm)

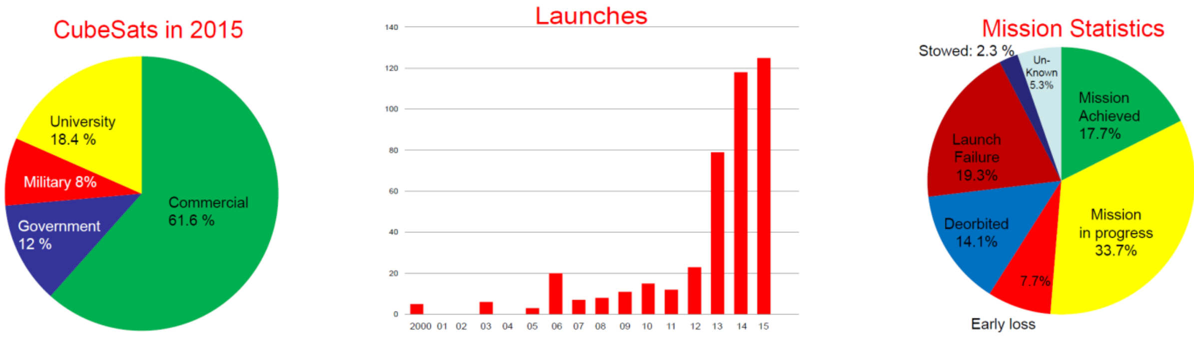


Figure 3. NanoSats Launched till 2015*Source: M.Swartwout*

Space Debris

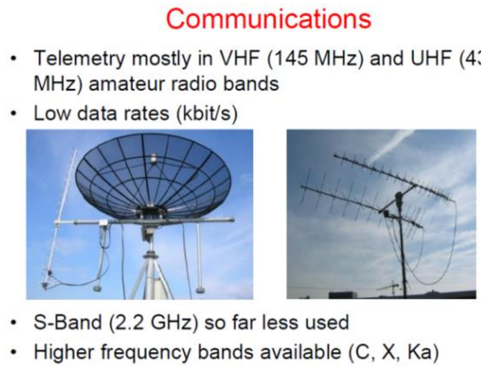
- *Increasing number of nanosatellites imposes a space debris risk*
- *LEO orbit crowded*
- *Orbit to comply with < 25 year orbital life-time*
- *Or: Active De-orbiting Mechanisms*
  - *Deployable sails/structures*
  - *Drag mechanisms*
  - *Propulsion (e.g. micro arc-jets)*

LEO contains relatively stable atomic and molecular particles. When the spacecraft moves at orbital hypervelocity, its surface is struck by particles that cause material recession. The most damaging is atomic oxygen (ATOX) [8]; among other impactors are N_2, O_2, *Ar, He, H*. The erosion process and rates rely on the material's composition. The most damaging are polymer based materials, while the impact on metals is not that significant, especially on aluminium (Al) which is commonly used for space structures due to its low density, radiation shielding capabilities, and manufacturability. For instance, an exposed Al surface to ATOX at an altitude of 500 km has an erosion rate of 7.6e-6 mm/year, however the same parameters applied to silver results in the erosion rate of 0.22 mm/year [9].

Against trapped and solar radiations, shieldings are implemented. The structure of the satellite can act as a radiation shield as well. For instance, in order to keep the total radiation dose below 10e4 rads per year at 4000 km, the required thickness of aluminium is 9 mm [7, p.71].

Micrometeoroids and Space Debris can have a fatal impact on the spacecraft structure at the orbital hypervelocity due to impacts (if the size of impactor is large enough). One can implement shielding against smaller objects. Also, thermal blankets decrease the impact of small objects [10, p.10-11].

The **plasma brake** (Figure 4a) is an end-of-life disposal technique for objects in the LEO. The infamous space debris issue was regulated with a limit in the orbital post-mission lifetime of 25 years or 30 years after launch for all satellites in the LEO [11]. The problems behind already existing debris are upcoming large constellations shown in Figure 4b. The probable collisions at orbital hyper-velocities (over 3 km/s) will cause defragmentation which will consequently result in an enormous escalation of small objects, better known as the Kessler syndrome, which will disable access to LEO if the escalated problem is ignored.



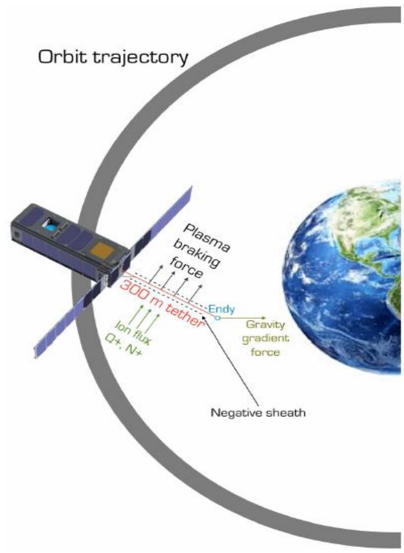


Figure 4a. Plasma brake concept for the gravity-stabilised tether

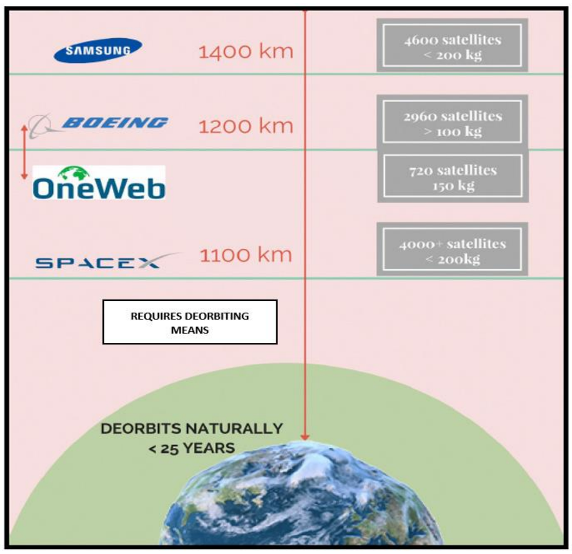


Figure 4b. Upcoming large constellations

Space Missions with Few Examples

- Astrobiology
- Astronomy
  - BRITE
  - CANIVAL-X (NASA): formation flying, virtual telescope
- Atmospheric Science
- Biology
- Pharmaceutical Research
- Earth Observation
  - Planet Labs (commercial)
- Space Weather
- Telecommunications
  - AIS (UTIAS, SPIRE- commercial)
  - ADS-B monitoring
  - Messaging
  - Amateur Radio
- Material Science
- Technology (OPS-SAT)

Major Components of Satellite Programmes

Space: Antenna systems, Attitude Control Systems, Communication Systems, Command Data Handling Systems, CubeSat Structures, Solar Panels,
Launch: CubeSat Deployers,
Ground: Ground Stations, Ground Support Equipment, Generic Engineering Model

a) Size & Objectives : CubeSat and Nanosat/Picosat Missions
b) CubeSat Platforms
c) Payload Development and Integration
d) Launch Services
e) Ground Stations
f) Commissioning and Operations Support

Work Group	***Major Team/Core Activities***
Antenna Systems	*Selection of Payload (Novelty)*
Attitude Control Systems	
Communication Systems	
Command Data Handling Systems	
CubeSat Structures	
Solar Panels	
CubeSat Platforms	*Payload Design and Development*
Payload Identification/Development	
System Integration	*Payload Integration*
Software Programming	*Mission Software Development (Programming)*
Launch Service	*Launch Logistics*
Ground Control Station	*GCS*
Commissioning and Operations Support	*Observation*
Review of Literature/Case Studies	*Documentation*
Testing and Analysis/ Failure Analysis	*System-Level Testing*

Applications of Satellite Programmes:
ISISpace has been working on training next generation scientists and engineers, performing small scale science missions or planning a novel application using a globe-spanning constellation etc. Potential space applications are listed below *(but not limited to the following)*:

1. ***Earth Sciences:*** *Nanosatellites for better understanding of our own planet*
2. ***Ship Tracking Services:*** *Near real time vessel tracking using satellite-AIS*
3. ***Aircraft Tracking:*** *Keeping track of aircraft on a global scale using ADS-B*
4. ***Space Research:*** *Small scale astronomy and exploration missions*
5. ***Climate Monitoring:*** *Network of satellites to monitor climate change*
6. ***Earth Observation:*** *Provide real-time imaging capability with satellite swarms*
7. ***Agriculture Monitoring:*** *Improve crop production using remote sensing data*
8. ***Microgravity Research:*** *Use the space environment to gain new insights*
9. ***Pipeline Monitoring:*** *Monitor critical infrastructure using satellites*
10. ***Signal Intelligence:*** *Use small satellites to ensure the security of our nation*
11. ***Education and Training:*** *Train the next generation scientists & engineers*
12. ***Telecommunications:*** *Provide global connectivity using small satellites*
13. ***Technology Validation:*** *Test your latest technologies onboard a small satellite*

Various Successful Strategies to Nurture Interest and Mobilize Passionate Workgroups/Team
What is a CanSat?
A CanSat is a simulation of a real satellite. All systems and subsystems are housed in a soft drink “can” shaped structure which can hold up to 350 ml. Building a CanSat is an economical way to gain basic knowledge and skills in Space Engineering for teachers and students, also, to experience engineering challenges when designing Satellites which has to survive in the hostile space environments! Students are able to design and build a small electronic payload that can fit into the cans of 350 ml. CanSat is launched by Rocket, Balloon, Plane or Drone and is carried to apogee. With the Parachute, the CanSat slowly descends to the ground and carries out its mission during descent (for example: measures air pressure and temperature and sends telemetry). By analysing the data collected by CanSat, students will analyse the reasons for its success or failure of the mission. It is an affordable process to keep the passionate students engaged and in the process the team acquires adequate fundamentals/knowledge of system engineering along with necessary systems and subsystems to build their CubeSat!

Space engineering learning, based on the CanSat/Rocketry concept, gives an opportunity to the students to gain hands-on experience through a specific interdisciplinary project. Since this is a Space engineering project, teachers and students will gain experience from mission definition, conceptual design, through integration and testing, up until launching and actual system operation, i.e. experience from the whole Space project cycle and then participate in the CanSat/Rocketry Competition with its peers at home country and abroad. One of the main advantages of the CanSat/Rocketry concept is its interdisciplinary and multi-disciplinary in nature: combination of mathematics, physics, informatics/ programming, mechatronics, telecommunications, aviation and rocketry, mechanics, etc. Whenever the CanSat/Rocketry Teams Win or Lose in the Competitions, they have enough lessons learned in the process to cement their unity with the project and dos and don'ts as well! It helps the team members to get motivated and sustain their interest for learning and doing continuously till they launch their own CubeSat/PocketQube to LEO!

Benefits of CanSat/Rocketry Based Education:

CanSat/Rocketry is an effective educational tool for:

- Learning by doing and also provides an opportunity to "create" new CanSat/Rocket/PocketQube, which is the highest level of learning pedagogy as per Revised Bloom's Taxonomy (RBT);
- Involving students in technology and engineering as a practical complement to other, fundamental, subjects they study, such as mathematics and physics;
- Emphasizing teamwork where each student has a specific task/role that creates a sense of responsibility for him/her;
- Students gain experience of the complete process: defining the mission, design, development/ constructing, programming, testing, launching and analysis;
- Simple conducting experiments with balloon/rocket/plane/drone;
- Learning methods can be adapted to the age level of students, or to their needs and abilities;
- Students are able to analyze the reasons for success or failure after descending CanSat and Rocket to the ground;
- Acquired knowledge and experience can be applied to other projects as this concept enables obtaining of ideas and stimulates students' thinking;
- Useful for a further education/career guidance process;

Today, almost every country in the higher education system has a CanSat/CubeSat program, so the initiative to establish CanSat/Rocketry Championship at the Global level is additionally justified.

Facts as of 2020 January 1 *(Nanosatellite Database by Erik: https://www.nanosats.eu/)*

Nanosats launched: 1307
CubeSats launched: 1200
Interplanetary CubeSats: 2
Nanosats destroyed on launch: 87
Most nanosats on a rocket: 103
Countries with nanosats: 65
Companies in database: 467
Forecast: over 2500 nanosats to launch in 6 years

Design and Development of Indo-Serbian PocketQube, CanSat and UNITYsat:

TSC PocketQube V1(50 mm x 50 mm x 50 mm):

Power Specifications

- Total unit works at 3.3V.
- Battery Specs (planned to use): Li-po 3.6V @ 1240mAh.

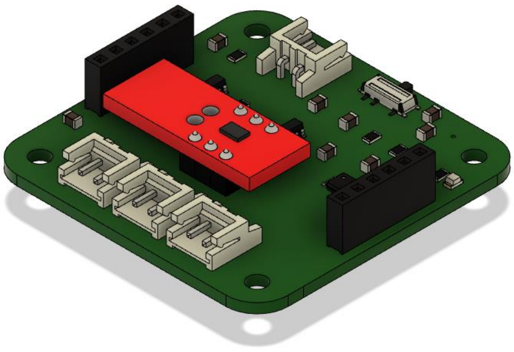
Board Specifications

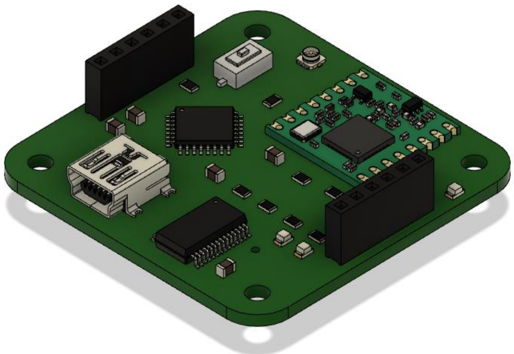
- Per board: 44.45mm (L) x 44.45mm (W) x 8.5mm (header height) + desired board thickness
- Available Board thickness 0.4, 0.6, 0.8, 1, 1.2, 1.6, 2.0 in mm
- 2 Layer Board.
- 4 M3 Mounting Holes.
- All Boards are interconnected in two rail configurations using Stack headers.

Board Description

EPS

- Can plug 3no of 2V @ 150mA solar cells (Dimension 5cm x 5cm x 4mm).
- Discharge Protection Circuit.
- 3V3 Voltage regulator.
- LiPo Fuel gauge (to monitor battery).
- Power Switch.

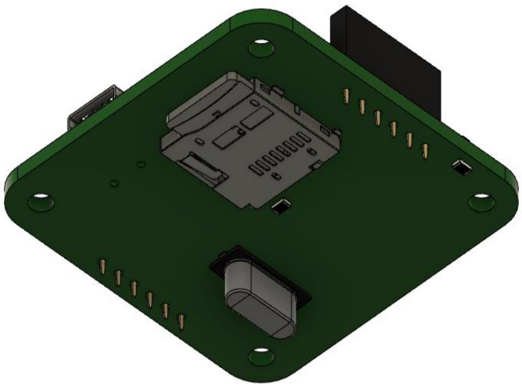


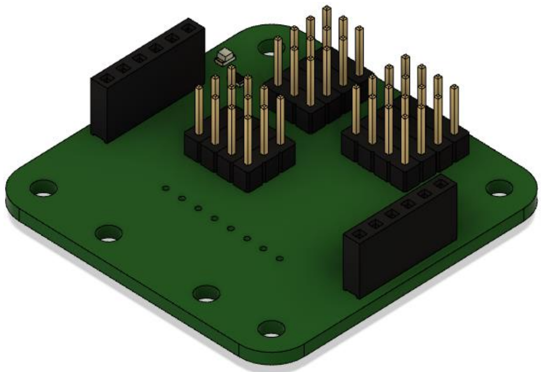


Snapshot of EPS v1 **Snapshot of OBC (Isometric Top View)**

OBC (with COM)

- Has On-board USB Interface for uploading and serial monitoring.
- Uses 8-bit AVR RISC-based microcontroller combines 32kB Flash, 2KB SRAM
- Uses SX1268 433/868 MHz **LoRa** Module. (http://www.dorji.com/products-detail.php?ProId=64)
- Can plug in 16GB micro SD Card for Data storage.
- Contains UFL Male Connector for antenna extension.



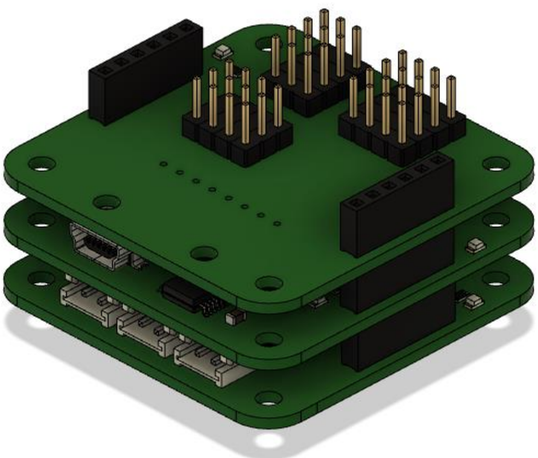


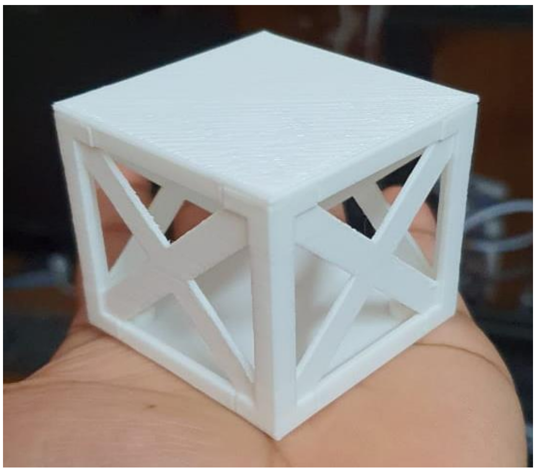
Snapshot of OBC (Isometric Bottom View) **Snapshot of Sensor Breakout Board (Isometric Top View)**

Sensor Breakout

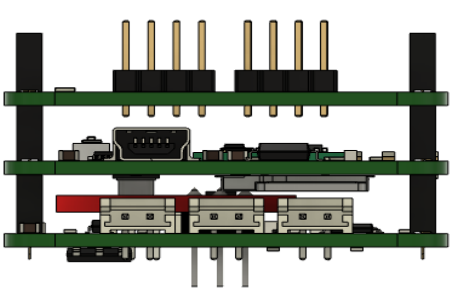
- Holds Temperature and 9-DOF (BMP280 + MPU9250) Sensors On-Board
- 4 I2C Ports.
- 4 Analog Pinouts
- 4 Digital Pinouts. (1 PWM).

Complete PocketQube View

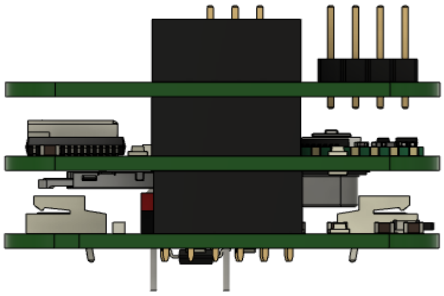




ISOMETRIC VIEW

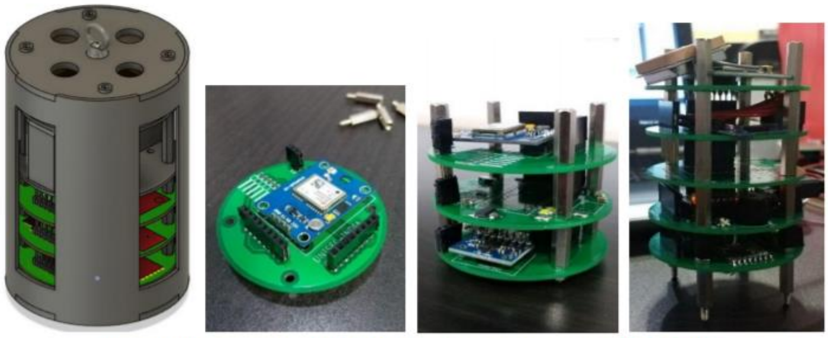


FRONT VIEW

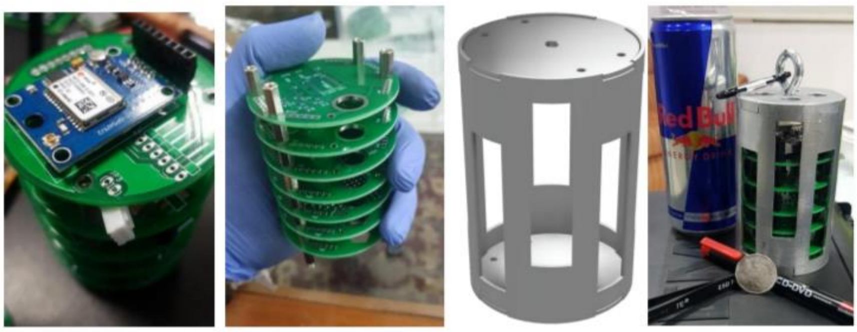


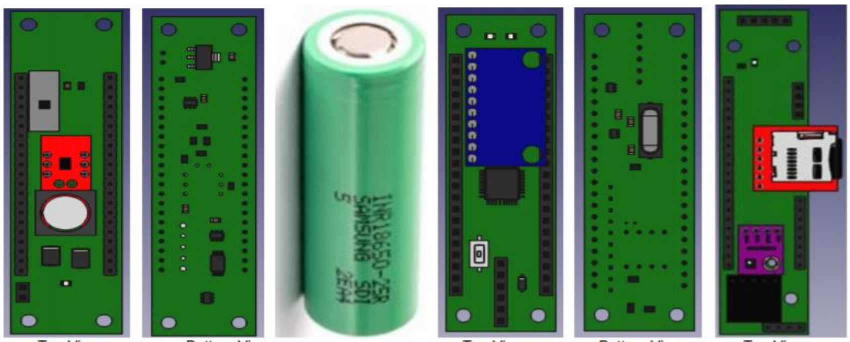
RIGHT VIEW

Indo-Serbian CanSat:



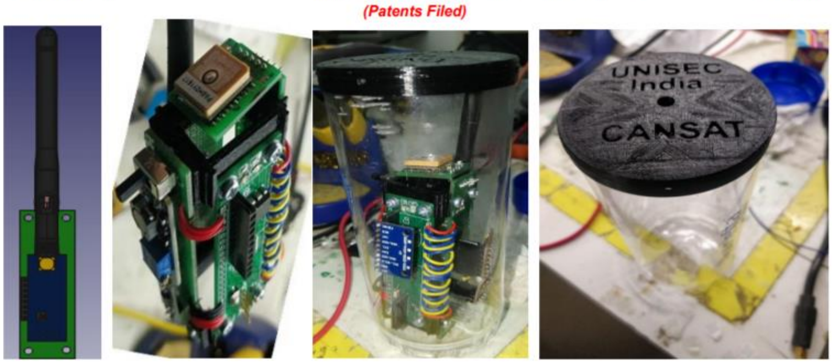
Views of Final Assembly of CanSat Built during above Workshops *(Patents Filed)*





Top View | Bottom View — **Battery Board**; **Battery**; Top View | Bottom View — **Micro Controller Board**; Top View — **Sensor Board**

(Patents Filed)



Indo-Serbian Collaboration has paved the way for Conducting Capacity Building CanSat Workshops in Eastern Europe along with CSPD, Serbia! Also planned to Organize Continental and Global CanSat/Rocketry Competitions 2020/2021 at Serbia and Other Host Countries by the end of 2020 onwards and Global Finals will be held at Serbia! Students' Exchange/Higher Education/Joint Development of Satellites for Former Yugoslavia Regions also have been planned.

UNITYsat:

The Unity Program *(originally conceived by CSPD, Serbia has been evolved into Indo-Serbian Collaboration)* represents a response to the increasing need of people and groups for easier access to Space, so as to attain sustainable progress in their work and development of this area. The concept itself emerged within the post-conflict region as an endeavour to re-establish the cooperation of the people within the region, but now during a completely different way, which in itself goes beyond the present mode of thinking and demands a brand new approach in international relations, whereby independence in creation of every participant isn't jeopardized, and on the other hand there's a relentless presence of the need of cooperation among the participants. In this way, everyone achieves both individual and group goals, and progress is inevitable. Technically, the Unity program relies on CubeSat standards (http://www.cubesat.org/), primarily by dimensions and basic characteristics. The 3U POD deployer carries several small satellites (UNITYsat) which will be delivered in Orbit.

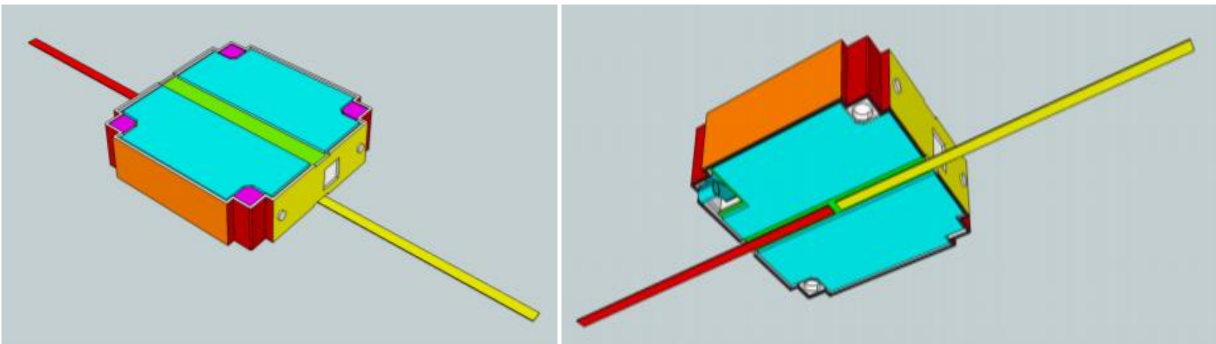
The main characteristics of the UNITYsat are as follows:

a) The chassis of every UNITYsat is made by combining of anodized aluminium and 3D printed filament;
b) Basic dimensions of every UNITYsat are 10.0cm x 10.0cm x 2.5cm or 1.25cm;
c) User/developer defines payload of its own UNITYsat with respect of the standards defined in this document;

The price is formed on the one UNITYsat: development kit + launch service. Although the volume of the one UNITYsat is 250 cm^3, the same rules (rights and obligations) are valid as for large satellites. The user/developer can put all the basic subsystems and payload in its own UNITYsat if meets the defined standards. Testing of each UNITYsat before the launching process is mandatory and this is also defined by mentioned standards.

- Each UNITYsat is sorted one on the other.
- The Remove Before Flight (RBF) must be on designated side of the UNITYsat (yellow side) in the form of switch, which must not exceed the external dimension of the designated side, i.e. it must be in the same plane.
- RBF is a mandatory part of each UNITYsat regardless of whether the user/developer has chosen to power its own UNITYsat only from batteries or uses other Solar Cells.
- Batteries may be fully charged during launching, but the user/developer must provide a place (port) on a designated (yellow surface in UNITY.skp) side of UNITYsat for external battery charging and diagnostics if desired. External battery charging and diagnostics will not be allowed after placing UNITYsat in 3U POD deployer!

The *Unity program* is an Open source program, which means that all components except the external structure can be designed and standardized by third parties, under a condition that everything complies with the standards defined in program document. This is one of the reasons why this program is called *Unity*.



UNITYsat Assembly

Defined Standards for UNITYsat

a) General Requirements

- All parts shall remain attached to the UNITYsat during launch, ejection and operation. No additional space debris shall be created. After few weeks (3-8 weeks) of useful life of the UNITYsat, it will deorbit naturally.
- Pyrotechnics shall not be permitted.
- No pressure vessels shall be permitted.
- No hazardous materials shall be used on a UNITYsat. If you are not sure if a material is considered hazardous contact us.

- UNITYsat materials shall satisfy the following low out-gassing criterion to prevent contamination of other spacecraft during integration, testing, and launch. *(Note: A list of NASA approved low out-gassing materials can be found at: http://outgassing.nasa.gov)*
- The latest revision of the UNITYsat Define Standards shall be the official version (http://2comnet.info/komsat/en/unity-program/), which all UNITYsat users/developers shall adhere to.

b) UNITYsat Mechanical Requirements

The UNITYsat configuration and physical dimensions shall be per UNITY.skp mentioned in Program Document *(which will be shared among interested Teams/Countries after signing NDA).*

- The UNITYsat shall be 109.0+0.1 mm wide (X dimensions per UNITY.skp).
- The UNITYsat shall be 109.0+0.1 mm wide (Y dimensions per UNITY.skp).
- A single UNITYsat (basic dimension) shall be maximum 25.0 mm tall (Z dimension per UNITY.skp), including antennas and Solar cells (if exist). *(Note: Users/developers should keep in mind that external structure (Anodized aluminium) of the UNITYsat will be delivered to each user/developer after additional purchase of structure. It is a prerequisite for participation in the program! In this way deviations in the external dimensions will be prevented. The internal/core structure which holds electronics can be 3D printed (ABS filament). User/developer can design the internal/core structure as it likes, but with respect of the Defined Standards in this document. In the UNITY.skp is given only an example of internal/core structure and changes are allowed!)*
- **Mass:** Each single UNITYsat (basic dimension) shall not exceed 220g mass; Two UNITYsat shall not exceed 440g mass and Three UNITYsat shall not exceed 660g mass etc.
- **Materials:** For external structure material is Anodized aluminium. For internal/core structure material ABS (3D printing filament) shall be used.
- The UNITYsat shall use separation springs with characteristics defined in Table 1 on the designated place *(white holes at the Bottom side in UNITY.sk*p). Separation springs with characteristics can be found using McMaster Carr P/N 84985A76. The separation springs provide relative separation between UNITYsats after deployment from the 3U POD Deployer.

Table 1: UNITYsat Separation Spring Characteristics

Characteristics	Value
Plunger Material	Stainless Steel
End Force Initial/Final	0.5 lbs./1.5 lbs.
Throw Length	0.05 inches minimum above the standoff surface

Spring Plunger

c) UNITYsat Electrical Requirements

Electronic systems shall be designed with the following safety features:

- No electronics shall be active during launch to prevent any electrical or RF interference with the launch vehicle and primary payloads. UNITYsat with batteries shall be fully deactivated during launch or launch with discharged batteries.
- The UNITYsat shall include deployment switch on the designated place (Blue switch on the Bottom side in UNITY.skp) to completely turn off satellite power once actuated. In the actuated state, the deployment switch shall be centered at the level of the bottom side of external structure (black surface in UNITY.skp).
  - All systems shall be turned off, including real time clocks.
  - The UNITYsat diagnostics and battery charging after the UNITYsat have been integrated into the 3U POD Deployer are not allowed. Note: All diagnostics and battery charging shall be done while the UNITYsat deployment switch is depressed.
- The UNITYsat shall include a Remove Before Flight (RBF) switch. The RBF switch shall be ON after UNITYsat integration into the 3U POD Deployer.
  - The RBF switch shall be accessible from the Access Port location (yellow surface in UNITY.skp).
  - The RBF switch shall cut all power to the UNITYsat once it is OFF.
- Batteries may be full charged during launching, but the user/developer must provide a place (port) on a designated (yellow surface in UNITY.skp) side of UNITYsat for external battery charging and diagnostics if desired. External battery charging and diagnostics will not be allowed after placing UNITYsat in 3U POD Deployer!

- An example of setting the Antenna and bending method will be performed live through the Workshop during the development process (example of dipole antenna 17.3cm x 2). This example is extremely important because based on it must be set up and bend and the Antenna(s) with other dimensions. The contact between the Antenna and the interior side of the 3U POD Deployer is NOT allowed!
- Deploying of Antennas and/or Solar cells etc. are allowed only by using Timer Switch (e.g. NiChrome timer switch) which countdown is triggered by separation of UNITYsats after ejection from the 3U POD Deployer in Orbit. The Timer countdown must last at least 15 minutes before deploying of Antennas and/or Solar cells.

d) **Operational Requirements**

UNITYsats shall meet certain requirements pertaining to integration and operation to meet legal obligations and ensure safety of other UNITYsats.

- Deploying of Antennas and/or Solar cells etc. are allowed only by using Timer Switch (e.g. NiChrome timer switch) which countdown is triggered by separation of UNITYsats after ejection from the 3U POD Deployer in Orbit. The Timer countdown must last at least 15 minutes before deploying of Antennas and/or Solar cells.
- Users/developers shall obtain and provide documentation of proper licenses for use of frequencies.
  - For amateur frequency use, this requires proof of frequency coordination by the International Amateur Radio Union (IARU). Applications can be found at www.iaru.org.
- Instead of using of UNITYsat Acceptance Checklist (UNITYsat AC) CSPD&ITCA/TSC shall conduct a minimum of one fit check in which user/developer hardware shall be inspected. A final fit check shall be conducted prior to launch.

e) Testing Requirements

Testing shall be performed to meet all requirements deemed necessary to ensure the safety of the UNITYsats and the 3U POD Deployer. Test plans that are not generated by the CSPD, Serbia & ITCA/TSC, India are considered to be unofficial. Requirements derived in this document may be superseded by launch provider requirements. All flight hardware shall undergo protoflight and acceptance testing.

At the very minimum, all ***UNITYsats shall undergo the following tests.***

- Random Vibration Random vibration testing shall be performed as defined by CSPD & ITCA/TSC and/or LV provider, or if unknown, GSFC-STD-7000.
- Thermal Vacuum Bakeout Thermal vacuum bakeout shall be performed to ensure proper outgassing of components. The test cycle and duration will be outlined by CSPD & ITCA/TSC and/or LV provider, or if unknown, GSFC-STD-7000.
- Visual Inspection Visual inspection of the UNITYsat and measurement of critical areas shall be performed both by user/developer and by CSPD & ITCA/TSC.
- Qualification UNITYsats may be required to survive qualification testing as outlined by the CSPD & ITCA/TSC and/or LV provider. If are unknown, GSFC-STD-7000 (NASA GEVS). Qualification testing will be performed at developer facilities. In some circumstances, CSPD & ITCA/TSC can assist developers in finding testing facilities or provide testing for the developers. Additional testing may be required if modifications or changes are made to the UNITYsats after qualification testing.
- Protoflight All UNITYsats shall survive protoflight testing as outlined by the CSPD & ITCA/TSC and/or LV provider. If are unknown, GSFC-STD-7000. Protoflight testing will be performed at developer facilities. In some circumstances, CSPD & ITCA/TSC can assist developers in finding testing facilities or provide testing for the developers. UNITYsats SHALL NOT be disassembled or modified after protoflight testing. Additional testing shall be required if modifications or changes are made to the UNITYsats after protoflight testing.
- Acceptance (depends in first place of LV provider / could be subject of changes) After delivery and integration of the UNITYsats into the 3U POD Deployer, additional testing shall be performed with the integrated system. This test ensures proper integration of the UNITYsats into the 3U POD Deployer. Additionally, any unknown, harmful interactions between UNITYsats may be discovered during acceptance testing. The 3U POD Deployer Integrator shall coordinate and perform acceptance testing. After acceptance testing, the UNITYsats will be removed from 3U POD Deployer to perform diagnostics through the designated UNITYsat diagnostic ports and then again integrated into the 3U POD Deployer to repeat the process one more time. Visual inspection of the system shall be performed by the 3U POD Deployer Integrator. The 3U POD Deployer SHALL NOT be disintegrated at this point.

f) Responsibilities

CSPD & ITCA/TSC responsibilities are to deliver purchased development kit to users/developers, to enable launch (through its LV provider partner) at a contracted price once capacity of 3U POD Deployer is full, to integrate the users/developers UNITYsats with 3U POD 7 Deployer, to ensure the safety of the 3U POD Deployer and protect the launch vehicle (LV), primary payload, and other Satellites. Responsibility for deploying UNITYsats in Orbit is on LV provider. Responsibility for functionality of the UNITYsats is on users/developers.

g) Applicable Documents

The following documents form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall take precedence.

- Cal Poly CubeSat Design Specifications Document (www.cubesat.org)
- LSP Program Level P-POD and CubeSat Requirements Document (LSP-REQ-317.01)
- General Environmental Verification Standard for GSFC Flight Programs and Projects (GSFC-STD-7000)
- Procedural Requirements for Limiting Orbital Debris (NPR 8715.6)

Frugal Way to Access Low Earth Orbit (LEO): Indo-Serbian Collaborative Efforts as a Case Study

Problems Identified by Space Enthusiasts to Access LEO:
Limited knowledge, Insufficient Experience, Money for Launch/Cheaper Launch, Time in General, Period of Time to Launch etc.
Tools Available to Access LEO: Acquired Knowledge, Technology, Collaboration / Teamwork, Motivation

Let's start with the problems of Limited Knowledge and Insufficient Experience using the Tool at our disposal. Due to the interdisciplinary nature of Space Engineering, Acquired Knowledge allows you to be aware of what you do not know and thus save you time and direct you. Collaboration/Teamwork makes up for time and knowledge- because not everyone knows everything, so teams are made up of people from many fields (inter disciplinary and multi-disciplinary teams). Technology speeds up the process and helps you to gain experience because it allows you to make mistakes that you can easily correct during the process.

Motivation is, of course, the basis of everything and is constantly present when someone is doing most exciting project such as "building their own satellite"! However, you all knew this, let's see specifically; we want to make a satellite, and we have the problems and tools listed. We decided to start gradually, from the beginning. We adapted the CanSat concept to elementary school age and started learning the same way as making a real satellite because CanSat is a replica of a real satellite and contains everything (all systems and subsystems) that has a real satellite, but with limited complexity. We made teams, shared tasks and everyone was given their own scope of work and responsibility. All participants (members of each team) are equally important. Then we raised everything to a higher level, high school and started studying Rockets. Both Rocket Engine Rockets and Water Rockets, constantly applying the acquired knowledge of fundamental subjects. We put together CanSat and Rocket and launch CanSat as a true satellite. Then things got even more interesting. Then the study at University came, we asked ourselves, what now ... it's not a problem to raise CanSat and Rockets to an even higher level, and even accredit Space engineering programs, but what's the point if we can't reach the goal because we are so small, how do we continue to improve ourselves? How can we contribute to development now? Do we have to wait for employment in some big Aerospace company or Agency?

History has taught us that no one should be underestimated and everyone should be given a chance if possible, if the goal is justified/correct/legitimate/democratic/inclusive. These issues occur even at the very beginning and therefore we again applied engineering approach and again start with thinking and rethinking... then we realized that we are constantly going around in circles, because new problem that has not been present has now appeared. And that problem is money for the launch / the cost of launch must be cheaper. OK, now we have the knowledge and we have some experience, but how to apply it completely, how to go further during study period. *(Digression: The cheapest launch is € 30,000-40,000-60,000 for PQ, which is unrealistic and unaffordable for many institutions/organizations, especially individuals).*

Then we applied a tool that has been used all the time, but in the process of learning, and that is collaboration. India and Serbia have found an optimum solution that big players made possible for small players and beginners (anyone either individuals or institutions who are interested to build and launch their own satellite). The UNITY Program was created, these big players are from ISRO/Roscosmos etc. India and Serbia have proposed a new approach in the educational process in which students have the opportunity to apply their theoretical knowledge through the creation of a real satellite during their studies and to motivate one another through competition with their colleagues/students from other institutions and automatically promote this program, which is actually common goal. This is UNITY because you cannot reach the goal easily (and cheaply through a frugal way). You are all independent in your work and will be independent in Orbit, but only together you can achieve that goal.

Consider the breadth (wideness) of this Program and how much UNITYs we actually have here and whether it may be a symbolic representation of humanity. Finally, remember the price of € 30k-40k-60k for PQ, Our proposed UNITYsat has allowed you to get twice as much (in satellite capacity) for € 25k-30k (Rs.21-26 Lakhs @ 1Euro = Rs. 84), and the whole Program applying the Open Source principle of development (which means you can save money, too). Cost effective launch opportunities have been studied extensively by Indo-Serbian Collaborative Team and they wish to share such knowledge to interested workgroups and teams Institutions) of various countries! World CanSat/Rocketry Championship (WCRC) has also been announced under consortium! *(For more details, visit: https://wcrc.world/)*

Hence, the entire project cost will be approx. Rs. 25-30 Lakhs (Euro 27k-35k) to design, fabricate, test and fulfil all the certifications before launching the UNITYsat and also including the cost launch etc! All this is very important because, the future of Space Science depends on our ability to attract and engage students into Science, Technology, Engineering and Mathematics (STEM) fields.

Reaching students earlier in their educational development cycle is critical in the development of a workforce for all countries so that they may remain competitive in the global marketplace. Teachers in K-12 education must engage students in STEM curriculum earlier to generate interest, develop skills and provide the educational foundation for students to build upon. The CanSat/Rocketry Program is made for this purpose and UNITY is a logical continuation for the common good. "Collaborative opportunities are always open for interested teams from any countries!"

Summary

- Nanosatellites and CubeSats have matured from pure educational projects to in-orbit demonstrators
- Proof that demanding scientific and technological missions can be carried out with small satellites at low cost and within short timescales
- Industry and Space agencies are increasingly using nanosatellite technology
- Commercial services are already in place using constellations
- Reliability increased: professional implementation
- Tailored PA/QA standards introduced
- Next astronomy mission can make use of recent developments in processors and communication subsystems
- Coordinated frequency bands should be used instead of traditional amateur radio bands to avoid interference and to provide higher data throughput
- Large number of spacecraft require strict adherence to existing rules and procedures to avoid harmful interference and space-debris problems
    - Authorisation, Registration, Frequency coordination and Compliance with "Code of conduct"

Turn-key CubeSat and nanosat/picosat missions are possible with the help of Innovative Solutions from Consortium of Space Scientists, MSMEs in Space Programmes under the initiative of CSPD/ITCA/TSC. ISISpace engineers were responsible for the integration of 101 CubeSats onto the PSLV launch vehicle of ISRO, a true world record has been created on 14 February 2017 with a launch of 104 Satellites (3 more by ISRO) by PSLV! Among these 101 satellites, there are 3 satellites where ISISpace, Netherlands played a major role in the design, development and implementation of the spacecraft. They are able to deliver small satellites ready for launch in 6 to 18 months. They also have ample experience with working with a broad range of standardized CubeSat and nanosat parts from various vendors and if needed, customized solutions will be implemented. Customers for satellite missions include government agencies, research institutes, universities and commercial companies. Good numbers of start-ups including TSC, India are working in the area of small satellites and building CanSats, CubeSats and PocketQubes!

Conclusion

The future of Space Science depends on our ability to attract and engage students into Science, Technology, Engineering and Mathematics (STEM) fields. Authentic, hands-on experience with space applications enhances engagement and learning in the STEM disciplines and can help to attract students to STEM careers [17]. The goal of the UNITY program is to provide interested students and small nations the opportunity to lead and participate in the development of a spacecraft payload through its life cycle in a frugal way. The learning experience will be enhanced with CanSat/Rocketry Competitions and development of PocketQube/CubeSat by the team through learning by doing and creating their own "satellite" (which is the highest in RBT Level of learning pedagogy) right from manufacturing, environmental testing, satellite integration, spaceport, launch vehicle, range and spacecraft operations etc. The UNITYsat Program of Serbia will provide a unique and important STEM opportunity for students/researchers in small countries to develop critical skills in systems engineering and space science that will complement their existing programs and initiatives. It is a cost effective, short-term program that provides students/researchers in small countries with an exciting opportunity to conduct valuable scientific space-based research.

Indo-Serbian Collaboration have paved the way for Global Competitions, starting at Continent Level to International Levels along with various knowledge Conferences, Workshops and exclusive Sensitization Seminar/ Workshop on "Capacity Building for Student Satellites and Rocketry" has been planned with the help of International experts, which will cover and provide overall bird's eye view of the above major components of Satellite Programmes. Indian Technology Congress Association (ITCA) and Committee for Space Programme Development (CSPD), Serbia has also agreed to network with Global leaders to get various opportunities for funding the entire projects on affordable terms and conditions. ITCA has also initiated 75 Students' Satellites Programme: Mission 2022 which has envisaged to launch 75 Students built Satellites to LEO to celebrate India's Freedom 75 Years (1947-2022) in India! Good amount of Academic Institutions and Universities have shown interest and started their own space projects at their campuses enthusiastically, since 2017-18.

Lead Agencies for 75 Students' Satellites Programme: Mission 2022:

Israel: *The Herzliya Science Center and Tel Aviv University*

India: *Indian Technology Congress Association (ITCA)*

Opportunities for Launch Support and Technical Collaborations: Identified Agencies:

1. Indian Space Research Organization , ISRO
2. Israel Space Agency and Israel Aerospace Industry
3. French National Space Research Center, CNES
4. United Nations Space Office – UNOOSA
5. GK Launch Services (GK) is an operator of Soyuz-2 Commercial Launches from the Russian Spaceports (Vostochny, Plesetsk) and the Republic of Kazakhstan (Baikonur)
6. World Federation of Engineering Organizations (WFEO)-ICT
7. BRICS Federation of Engineering Organisations
8. World Academy of Engineers
9. CANEUS Small Satellite Sector Consortium, Canada/USA
10. University Space Engineering Consortium (UNISEC)–Global, Japan; UNISEC-Serbia, India, Samara, Italy

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19. http://outgassing.nasa.gov
20. http://2comnet.info/komsat/en/unity-program/
21. https://wcrc.world/

Acknowledgement from Collaborative Organisations: *Indian Technology Congress Association (ITCA), TSC Technologies Private Limited, India and Committee for Space Programme Development (CSPD), Serbia thank profusely all the above authors and web portals/organisations for their original contributions in the area of small satellites and have provided very useful insights for better understanding of the subject.*

Indo-Serbia Collaborations: Looking for Stronger Ties!

Formation of WCRC: Genesis during International Conference @ Bangalore, India

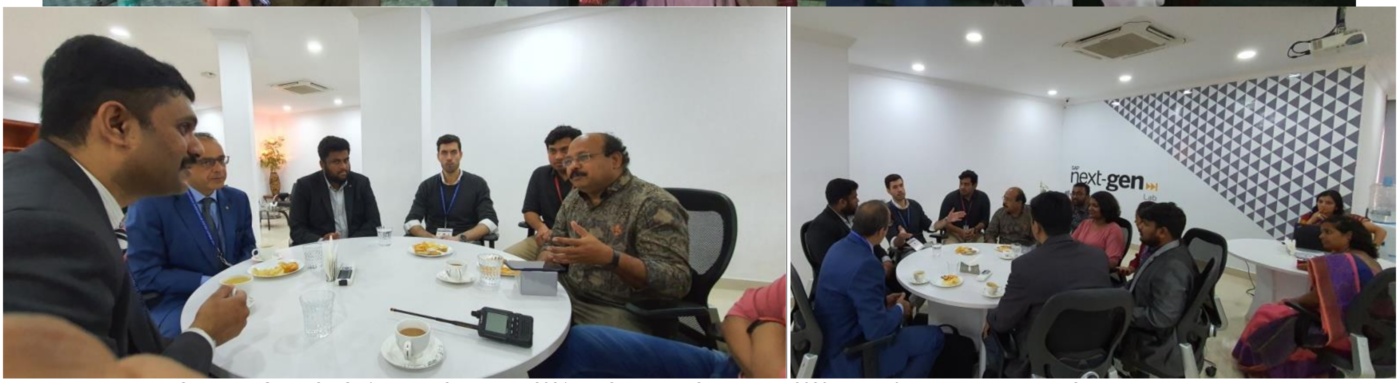
Formalised Indo-Serbia-Italy Collaboration! 19-20 December 2019

Award of Appreciation has been presented to Mr. Dušan Radosavljević, Head, Committee for Space Programme Development, Serbia, Prof. Santoni Fabio, University of Rome, Italy, by Mr. Carl Broadridge, Technology Service Center Lead, India, ANZ during ICIREM on19 December 2019 at NHCE, Bangalore, INDIA for their Contributions to NewSpace Era!

Signing MoU: Indo-Serbia Collaborations; Looking for Stronger Ties!

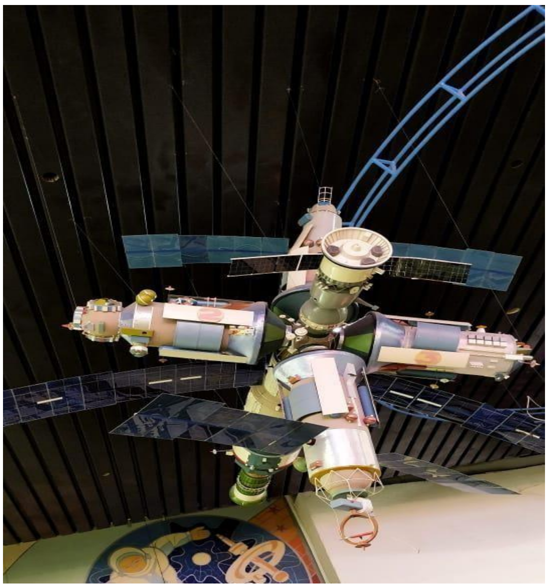
Indian Technology Congress Association President Dr L V Muralikrishna Reddy, Vice-President Dr Wooday P Krishna, Er D V Nagabhushan ,Secretary General Dr K Gopalakrishnan, Sapienza University of Rome Prof Sabio Santoin, Head of CSPD in Serbia Prof DusanRadosalvjevi at the Signing of Indo-Serbia MoU during an International Conference Organized by New Horizon College of Engineering, Bengaluru, INDIA on 19 December 2019.

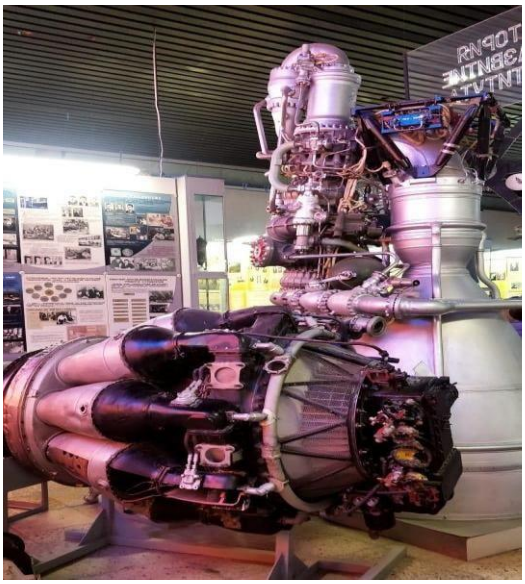
Formalised Indo-Serbia-Italy-Canada Collaboration! 19-20 December 2019



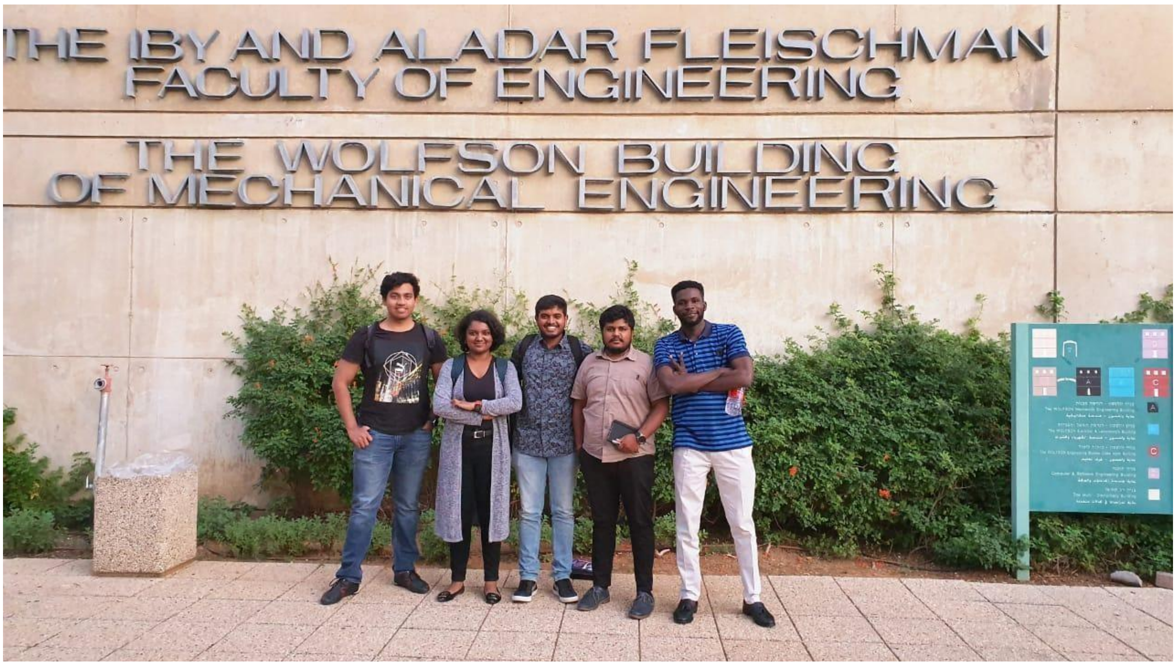
Interaction on Organizing Global CanSat/Rocketry Competition 2021 and Continental Competitions 2020 with Prof. Javeed Ahmed Khan, Canada, Mr. Dušan Radosavljević, Head, CSPD, Serbia, Prof. Santoni Fabio, University of Rome, Italy, Dr. K. Gopalakrishnan and his Students' Satellites Team at NHCE, Bangalore, India on 21 Dec 2019

WCRC Core Team @International Summer School Samara University, Russia





WCRC Core Team Members @ COSPAR EVENT, Tel Aviv University, Israel



WCRC Core Team @ UNISEC Global meet, Tokyo University, Japan

TSC Team Represented by Nikhil, Denzel, Sainath and Our Mentor Dr. K. Gopalakrishnan

Networking Meetings/MoUs for Indo-Serbia Collaboration and Promotions of WCRC

Signing MoU: Indo-Serbia Collaborations; Jeppiaar Institute of Technology, Chennai!

Networking Meetings/MoUs for Indo-Serbia Collaboration and Promotions of WCRC

Networking Meetings/MoUs for Indo-Serbia Collaboration and Promotions of WCRC

Interactions at Adhiyamaan Engineering College, Hosur, Tamilnadu

Crescent University, Chennai, Tamilnadu

Networking Meetings for Indo-Serbia Collaboration and Promotions of WCRC

Interactions with Dr. Mylswamy Annaduari, Outstanding Scientist, ISRO

At his Residence in Bangalore, India

Dr. M. Annadurai is Former Project Director, Chandrayaan 1 & 2 (Moon Mission) & Programme Director, Mars Orbiter Mission and Director, ISRO Satellite Centre

Celebrate India's Freedom: 75 Years!
75 Students' Satellites will be Launched by 2022!

Supporting Countries/Agencies: India, Israel, France, Russia, Canada, Netherlands, UK, USA, Japan, Italy, Serbia & Germany

India Israel France Russia Canada Netherlands UK USA Japan Italy Serbia Germany

International Space University, Strasburg, France

1st International Seminar on Students' Satellites, Bangalore, INDIA

For More Information and Photo Gallery, Visit to[*https://drive.google.com/drive/folders/1PISlSWwoPEhXjLxLUikPGtdU7B3oBDMR*](https://drive.google.com/drive/folders/1PISlSWwoPEhXjLxLUikPGtdU7B3oBDMR)

1st International Seminar on Students' Satellites, Bangalore, INDIA

2nd International Seminar on Students' Satellites, Bangalore, INDIA

2nd International Programme on Students' Satellites: Mission 2022" held during 28-29 Nov 2018 in Association with ITCA, TMIsat, Israel, CSPD, Serbia and UNISEC India at FKCCI Auditorium, Bangalore, INDIA

National Seminar on New Space-An Era of Small Satellites: Opportunities and Challenges

11 April 2019 at New Horizon Knowledge Park, Bangalore, INDIA

L to R: Dr.K.Gopalakrishnan, Secretary General, UNISEC India, Mr. R.K Rajangam, President, Planet Aerospace, Padmashri. Prof. Vasagam, Dr.Manjunatha, Principal, NHCE and Mr. Venkat Rao, Former Systems Engineer for Electro-Optical Payloads of ISRO

Section of Gathering during the Inaugural Session of National Seminar on “New Space: An Era of Small Satellites: Opportunities and Challenges”

2019 International CanSat/Rocketry International Competition held at Serbia

Organised by Committee for Space Programme Development (CSPD), SERBIA

Indian Technology Congress Association

Комитет за развој свемирског програма
Република Србија
21000 Нови Сад
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Committee for Space Programme Development
Republic of Serbia
21000 Novi Sad
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ITCA, TSC and CSPD, Serbia Initiatives!



31 August 2019 Sri Shakthi Institute of Engineering and Technology, Coimbatore, Tamil Nadu




25 October 2019 K.S. Institute of Technology, Bangalore, Karnataka, INDIA

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Indian Delegation Visited Sapienza University, Rome: Interaction with Prof. Fabio, PoC, Italy

ITCA and CSPD, Serbia Initiatives!

NHCE Satellites Team with **Ms. Lucille Baudet - Open Cosmos, UK, Dr. Margarita Safonova - Russia and Dr. J. Ramkumar, Professor, IIT Kanpur** during interaction to Evolve Creative/Novel Payload for the CubeSat at NHCE (03 Sept) at Conference Room.



22 November 2019 at NHCE, Bangalore: Representative from 15 Technical Institutions Attended **Margdarshan Scheme Inauguration/Workshop on CanSat!**

Students' Teams during Hackathon/CanSat Workshop Conducted by CSPD, Serbia/UNISEC India at Bangalore

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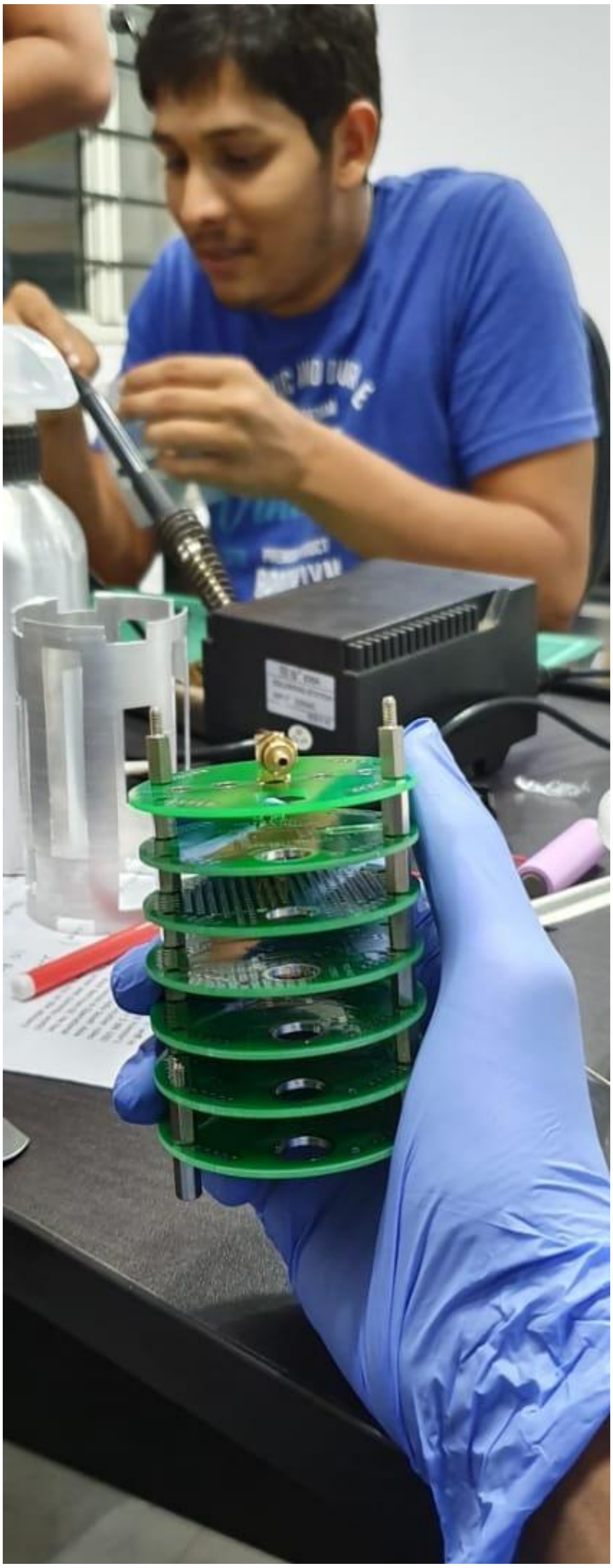
TSC



TSC Technologies P Ltd (TSC): Successful Start-up Nurtured by ITCA, NHCE, UNISEC India and CSPD, Serbia

CanSat Launched by OctoCopter at New Horizon Knowledge Park, INDIA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(Ministry of HRD Initiative)
Geekspace Labs
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ENGINEERS WITHOUT BORDERS India
UNISEC GLOBAL
University Space Engineering Consortium
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