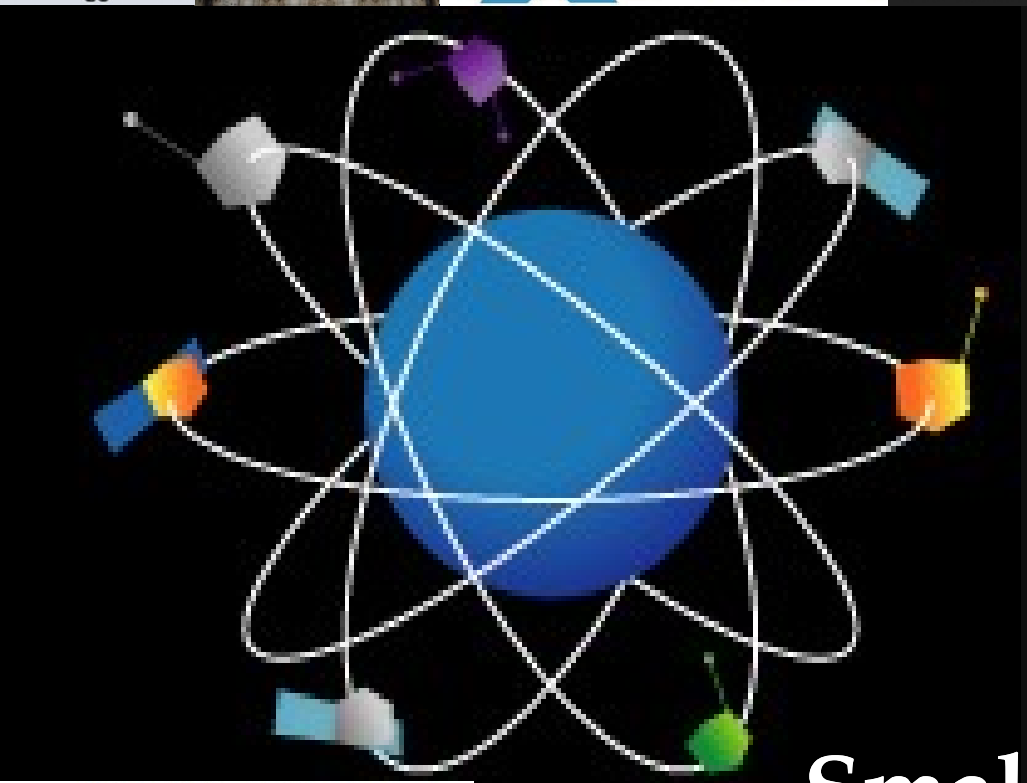

Sofia University "St. Kliment Ohridski",
Aerospace Student Seminar
3rd of June 2016, Faculty of Physics A315
Plamen I. Dankov
„Small Satellites and Aerospace Engineering Education"

The small satellites – a new different world in the Space!



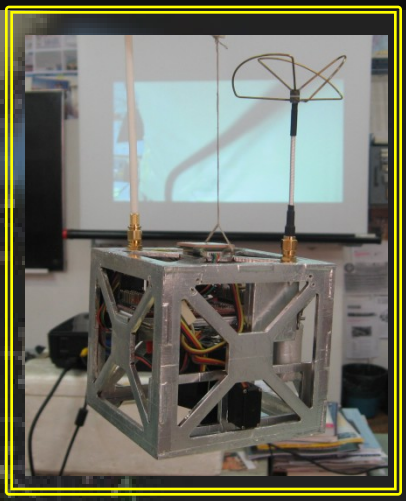



Small satellites:

Weight: < 50 kg;

LEO altitude: 500-1500 km;

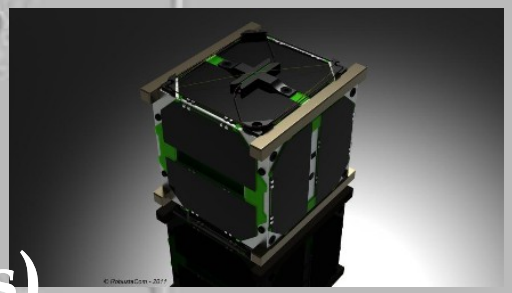
Time of life on orbit: 1-3 years



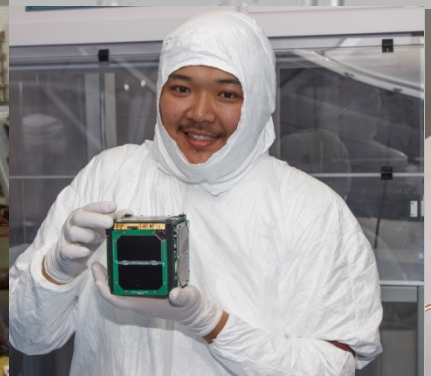
Type	Mass (kg)	Cost (US $)	Time of Development from Proposal to Launch
Conventional large satellite	>1000	0.1-2 B	>5 years
Medium satellite	500-1000	50-100 M	4 years
Mini-satellite	100-500	10-50 M	3 years
Micro-satellite	10-100	2-10 M	~1 year
Nano-satellite	1-10	0.2-2 M	~1 year
Pico-satellite	<1	20-200 k	<1 year
Femto-satellite	<0.1	0.1-20 k	<1 year

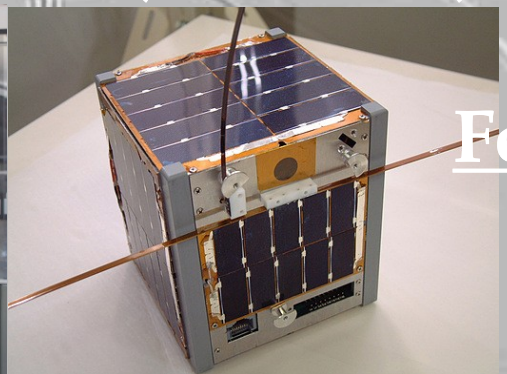
Micro (μ) Satellites

Pico Satellites

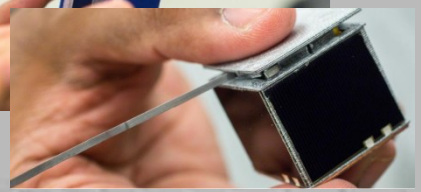


Nano-satellites (CubSat's)





Femto Satellites



The 4th
Mission Idea Contest
For Micro/Nano-satellite Utilization
From Concept to Reality

UNISEC
University Space Engineering Consortium

UNISEC EUROPE
University Space Engineering Consortium

CASTRA

Outline

- Small satellites as innovative investigation tools from the near Space and as educational instruments (university CubeSat's; weight <1 kg; 10*x*10*x*10 cm).
- Statistical data for CubeSat's on orbit; conclusions.
- Aerospace engineering education in Sofia university
- Our educational project in the area of small aerospace vehicles.
- How to be member of UNISEC Global – UNIversity Space Engineering Consortium

Main Applications of the Small Satellites

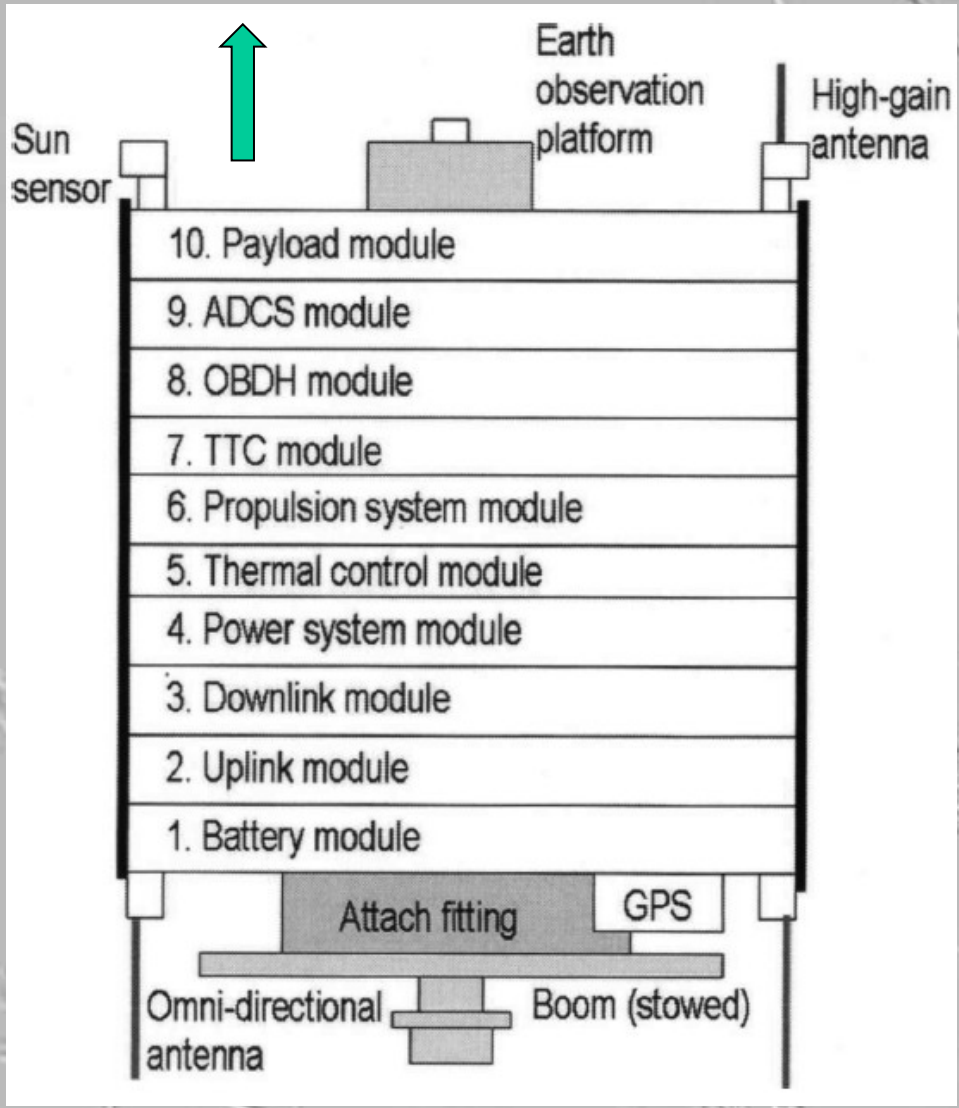
1. Observation of the Earth surface from the near Space (several hundred km) – new more effective technical tool for remote sensing

2. For solving of variety of scientific problems and test of new technologies – considerable less expensive than using of bigger satellites (>100 kg)

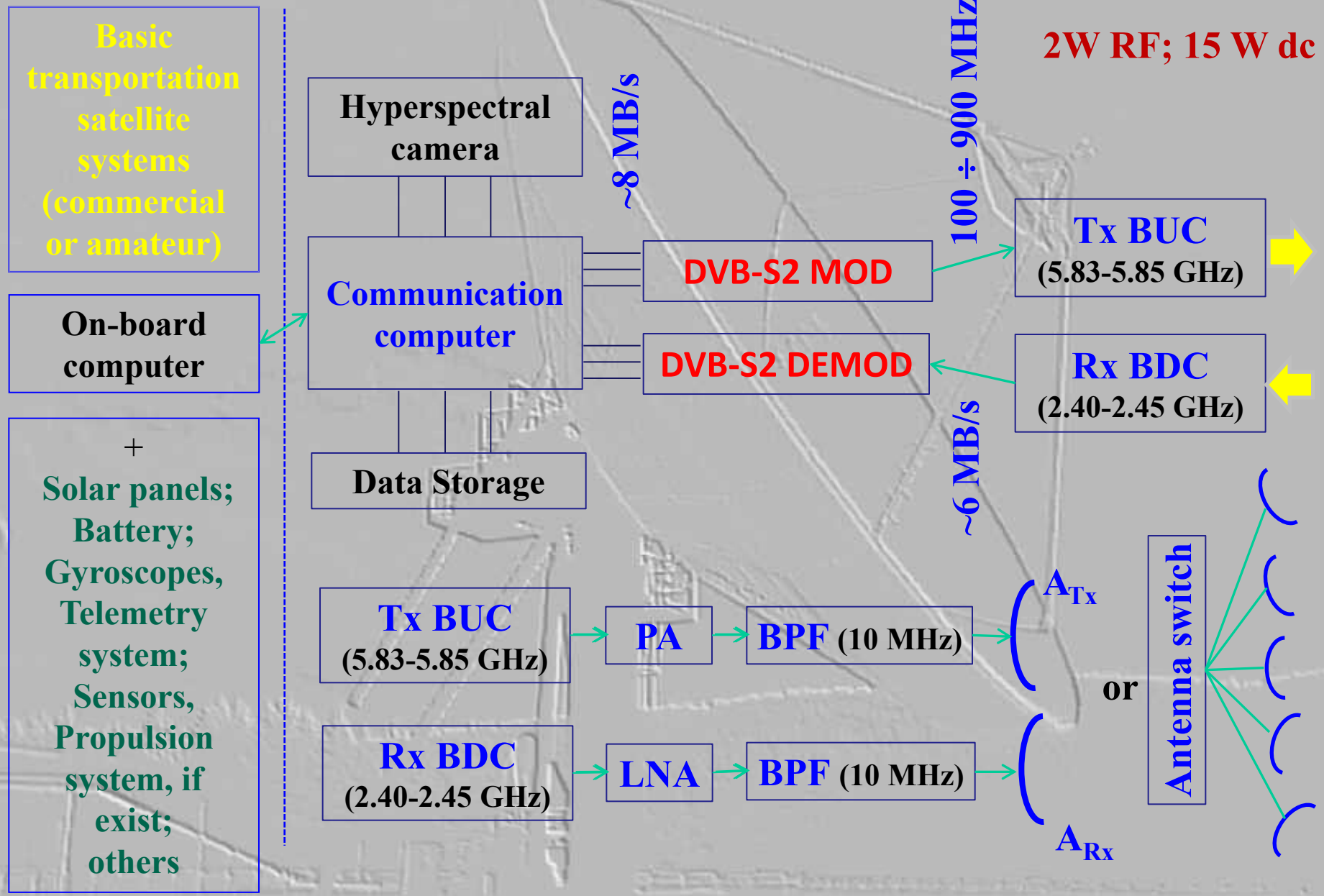
3. For communication purposes and data transfer over satellites on LEO altitudes – online (IoS: Internet over Satellites) or offline communication sessions (Store-and-Forward technology).

4. For education of students and young people in the area of aerospace engineering and new technologies for efficient access to the near Space.

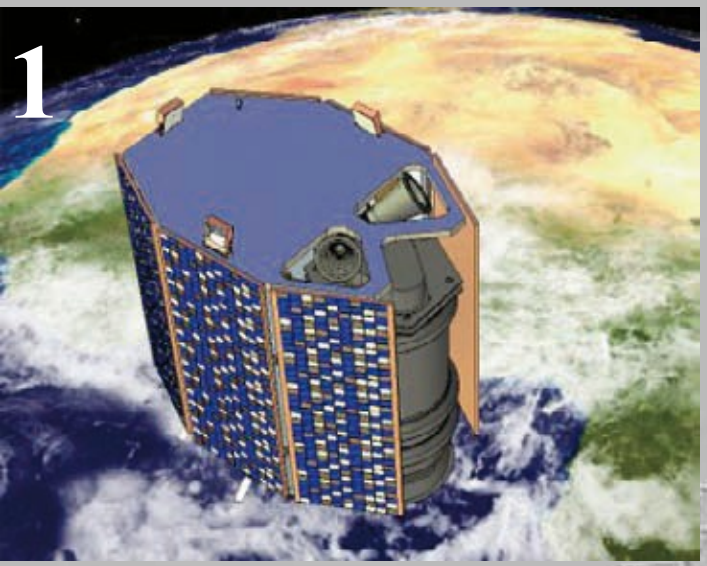
Small satellite – basic scheme

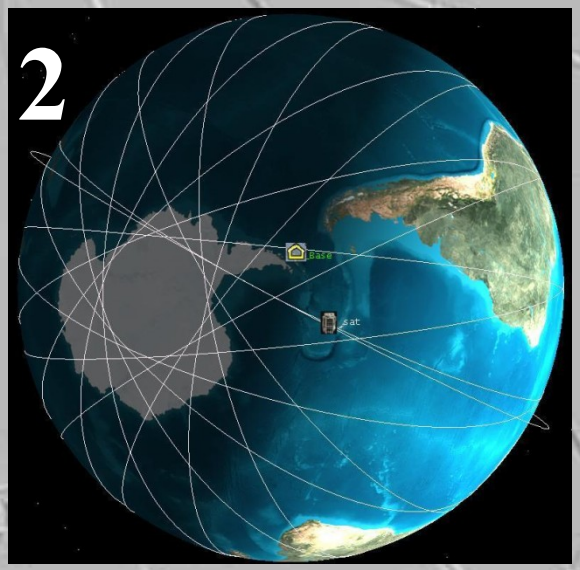


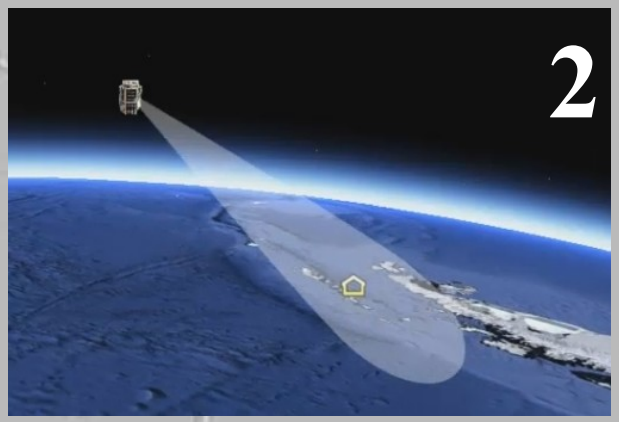
Small satellite – communication scheme



Communication function of the small satellites





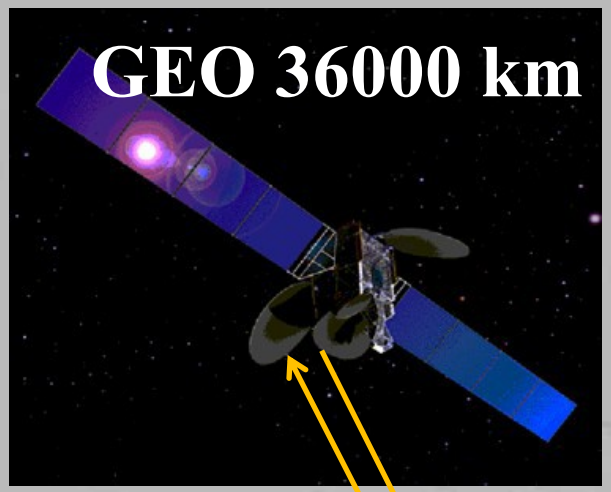


1) To take of pictures with high resolution and to transmit data to the ground station with big data rate.

2) „Mail box“ – „Store and Forward” communication technology.

3) TV pictures of the Earth from the near Space?

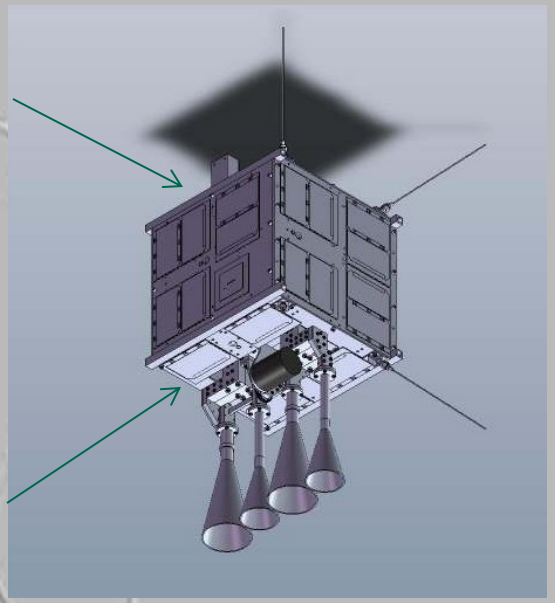
Communications trough the forward and backward panel of the small satellites

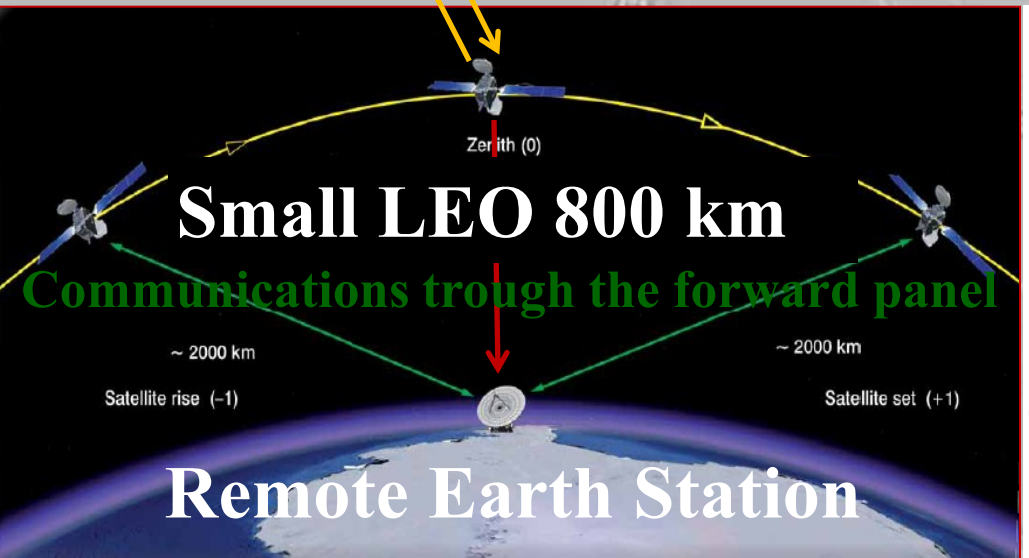


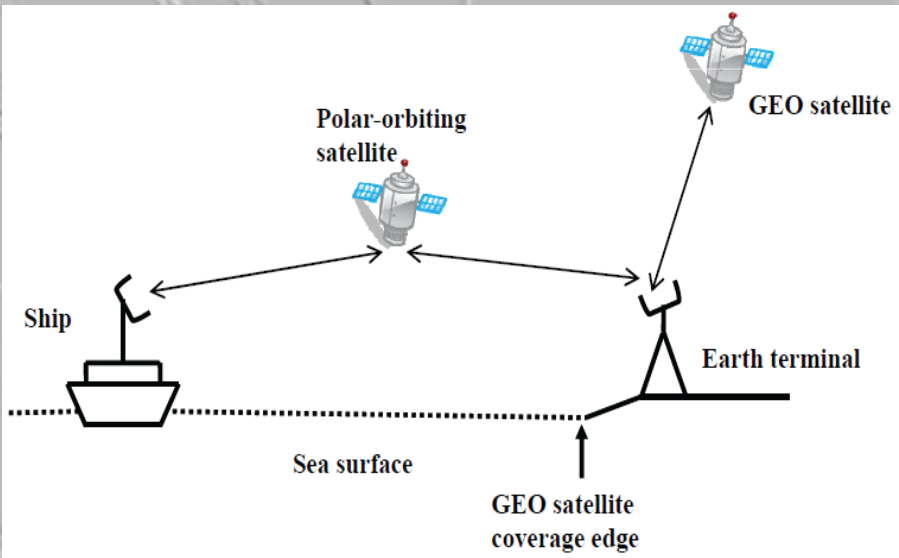
Communications trough the backward panel

Backward panel – always orientated to the Space

Forward panel – always orientated to the Earth







The small satellite as an education tool

April 8, 2016

NASA Reaches Out to Universities for Small Satellite Technology Collaborations

NASA is once again extending an opportunity to teams at colleges and universities with campuses in the U.S. to propose small spacecraft technology projects to be conducted in collaboration with NASA researchers. The Smallsat Technology Partnerships solicitation is being issued by the Small Spacecraft Technology Program, as an appendix to the Space Technology Mission Directorate's (STMD) NASA Research Announcement (NRA) for 2016.

Small spacecraft, as small as the size of a four-inch cube, represent a growing field of space research in which universities have often led the way. Small spacecraft, or smallsats as they are commonly called, can provide an alternative to larger, more cost
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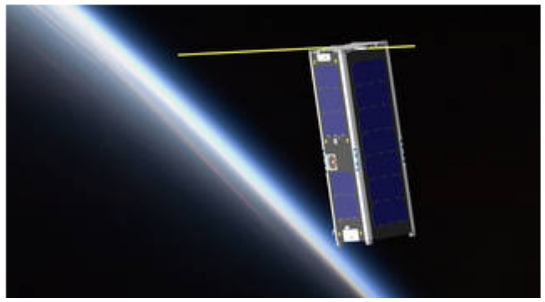


The development of small satellites and CubSat's in the world Universities is considered as extremely important

Feb. 26, 2016

NASA Invites Media to Talk to Small Satellite Experts, Tour Labs

NASA will ho
assembly an

Feb. 17, 2016

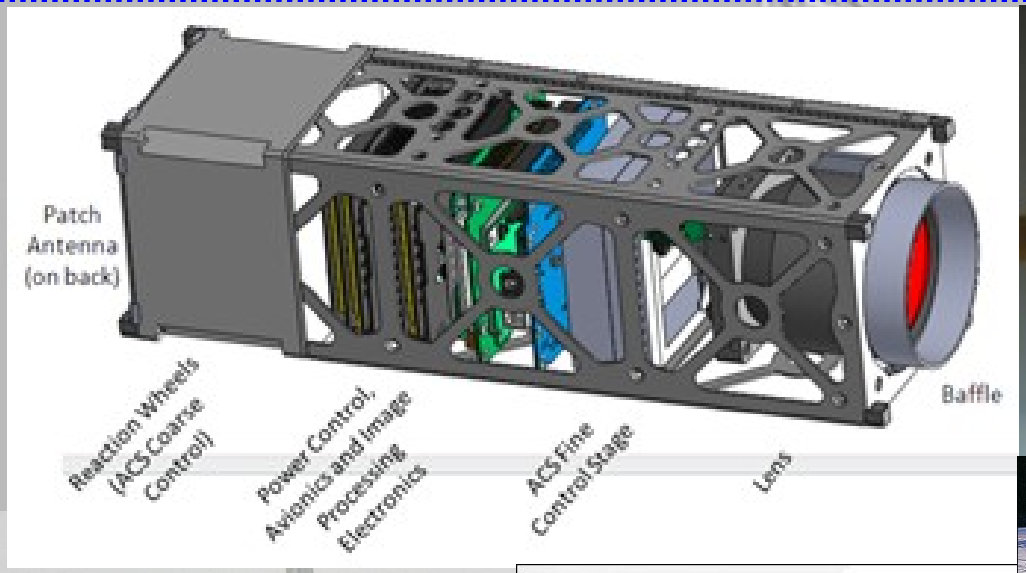
How a NASA Team Turned a Smartphone into a Satellite Business

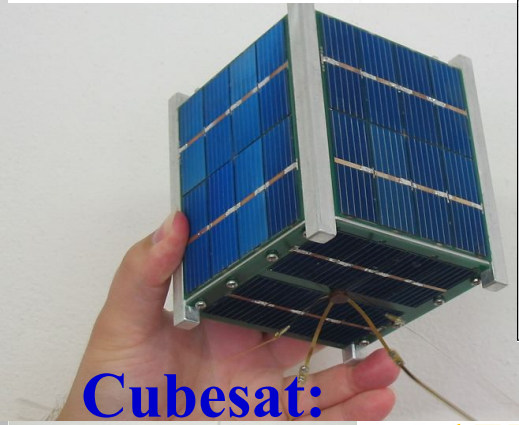
Satellites aren't small or cheap. The Solar Dynamics Observatory launched by NASA in 2010 weighs about 6,800 pounds and cost $850 million to build and put into orbit.

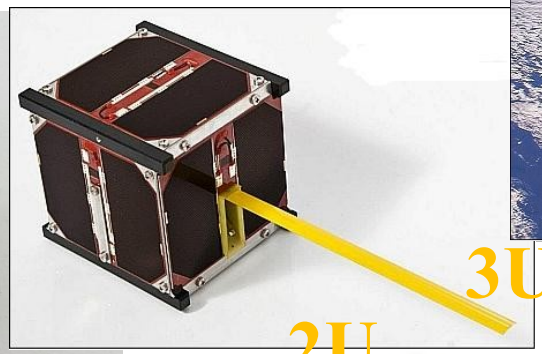
Even the satellites built under NASA's Discovery Program, aimed at encouraging development of low-cost spacecraft, still have price tags beyond the reach of smaller companies or research organizations: one such satellite, the sun-particle collecting Genesis, ran up $164 million in expenses despite its modest design and mission.

But that's beginning to change as increasingly powerful technology comes in increasingly smaller packages. For example, in 2010 NASA and the Department of Defense launched the Fast, Affordable, Science and Technology Satellite, aptly called FASTSAT. Weighing in at just 400 pounds, FASTSAT cost just $10 million and carried out six experiments in orbit, proving that low-cost, quick-to-assemble spacecraft were possible.

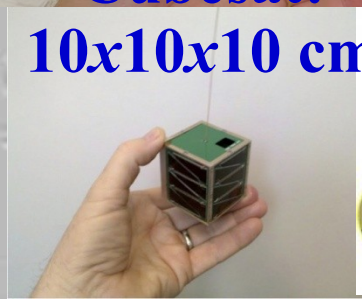
The small satellite consists of almost all important equipment, included in a big satellite, but in considerable cheaper (COTS) implementation





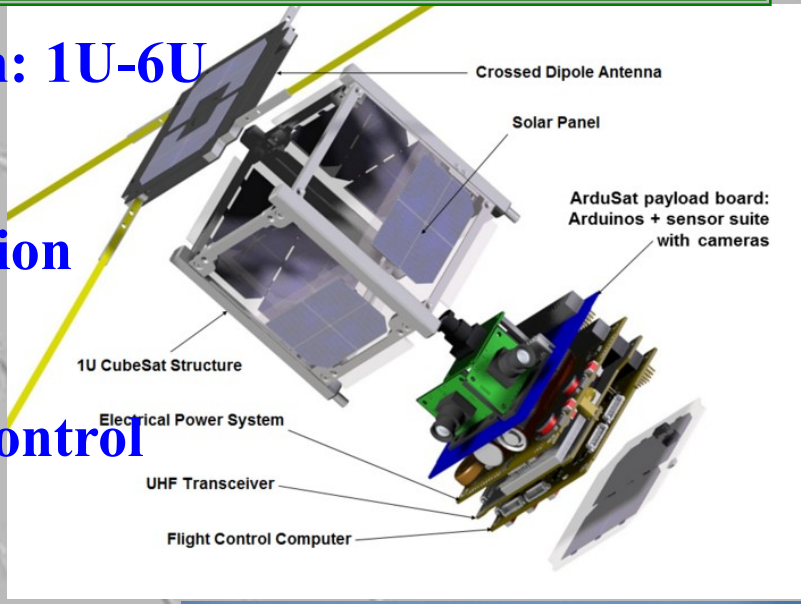


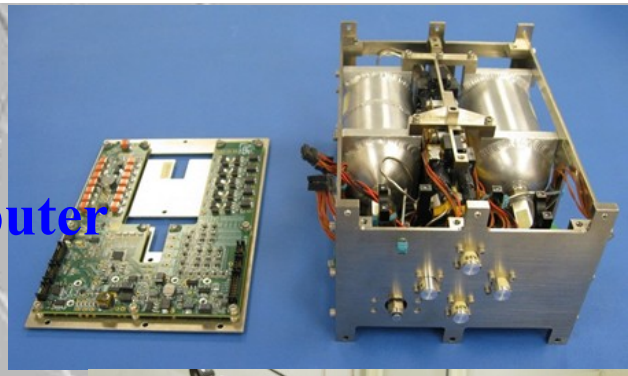
Cubesat:
10x10x10 cm



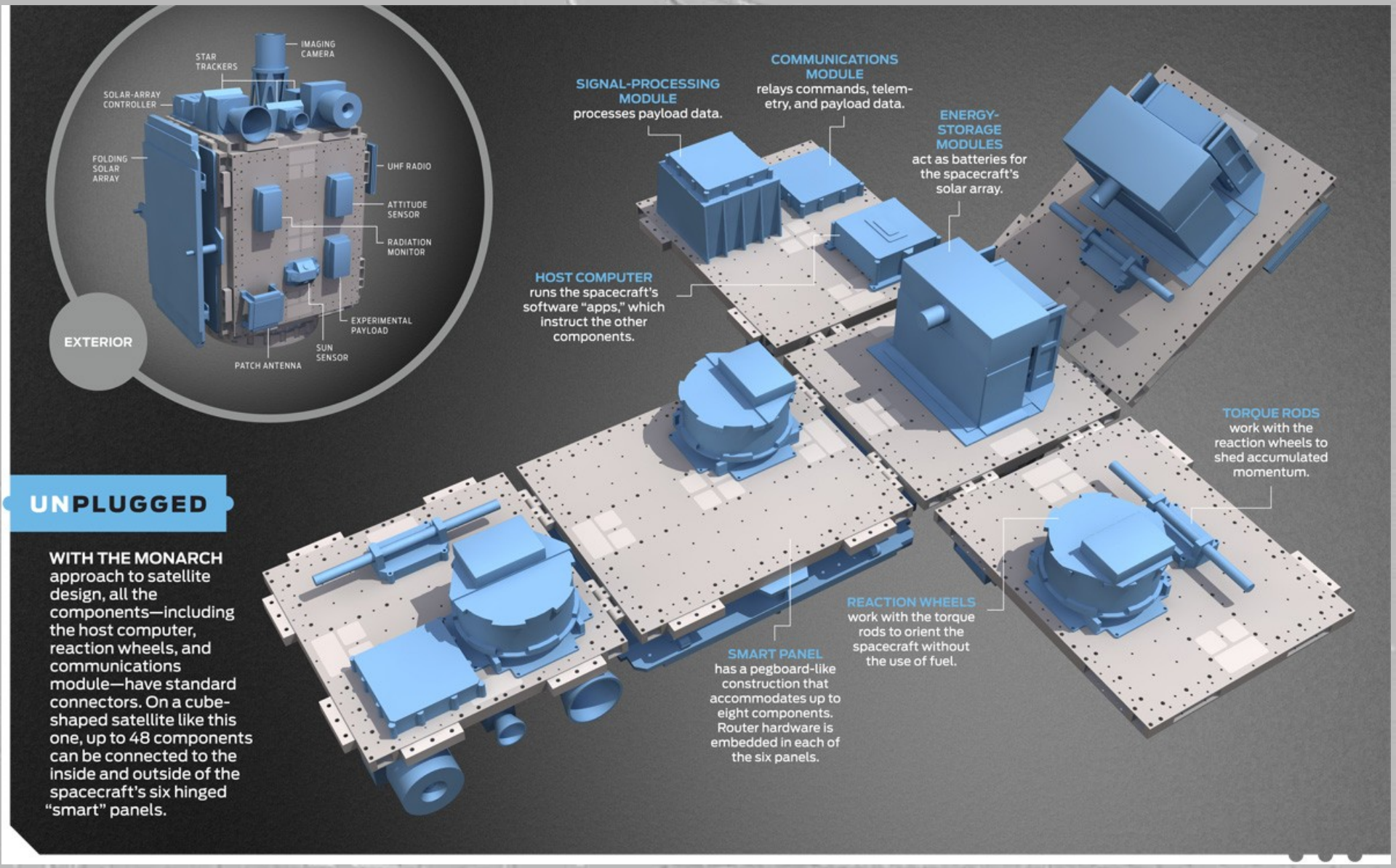
Main subsystems in the small satellite and areas for education

1. Precise modular mechanical construction: 1U-6U
2. Photovoltaic system and batteries
3. Electrical power system; power distribution
4. Telemetry, tracking and commands
5. Altitude determination and orientation control
6. Command and data handling
7. Guidance and navigation
8. Thermal conditions and thermal control
9. Flight control computer + communication computer
10. Onboard electronics, transmitters, receivers
11. Communication system; antennas
12. Satellite thrusters: ionic, plasma, cold gas, resistojets
13. Optical, infrared and hyperspectral cameras and sensors
14. Scientific and test equipment



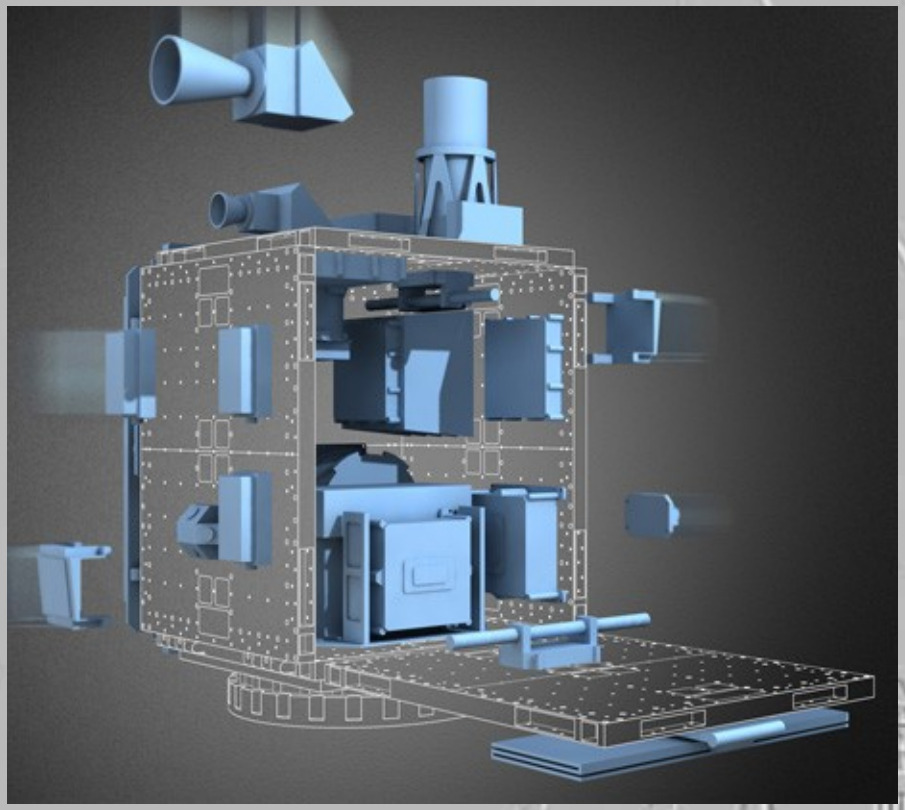


Concept for full standardization and modular architecture (Example: "Plug-and-Play" technology)



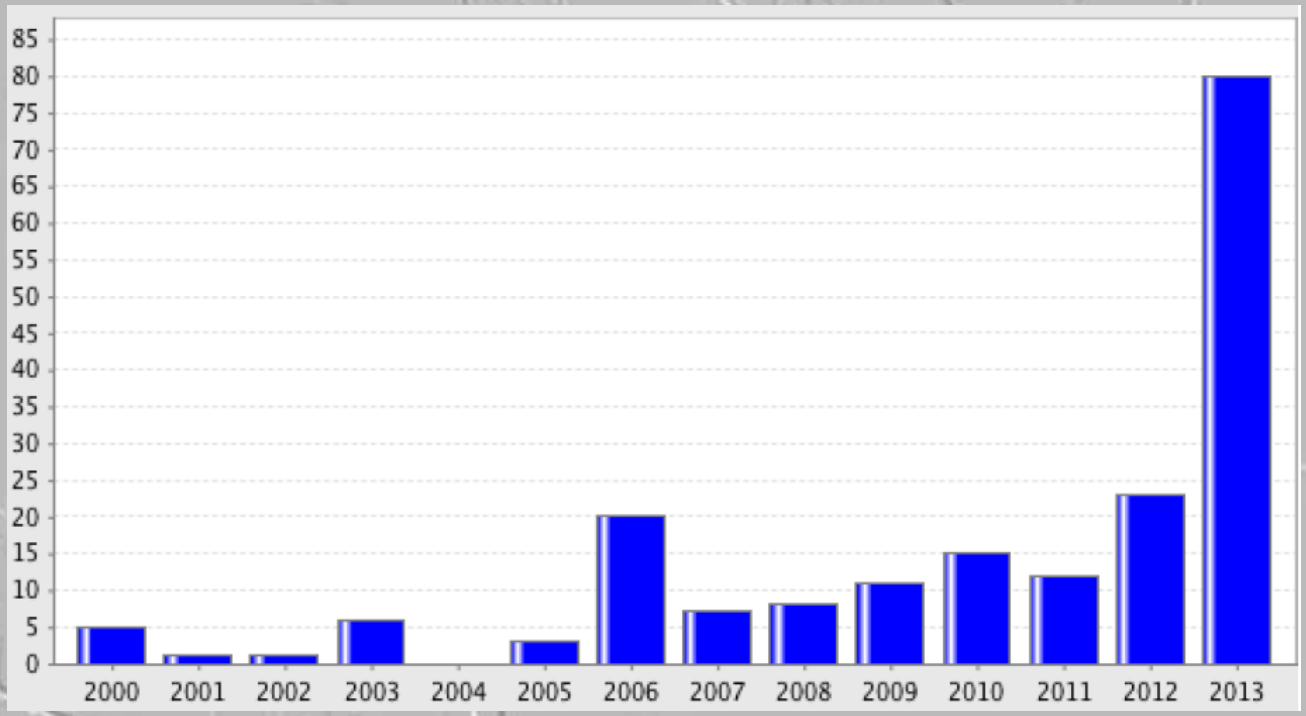
Plug-and-Play Satellites Air Force Research Lab

http://spectrum.ieee.org/aerospace/satellites/us-air-forces-plugandplay-satellites/1

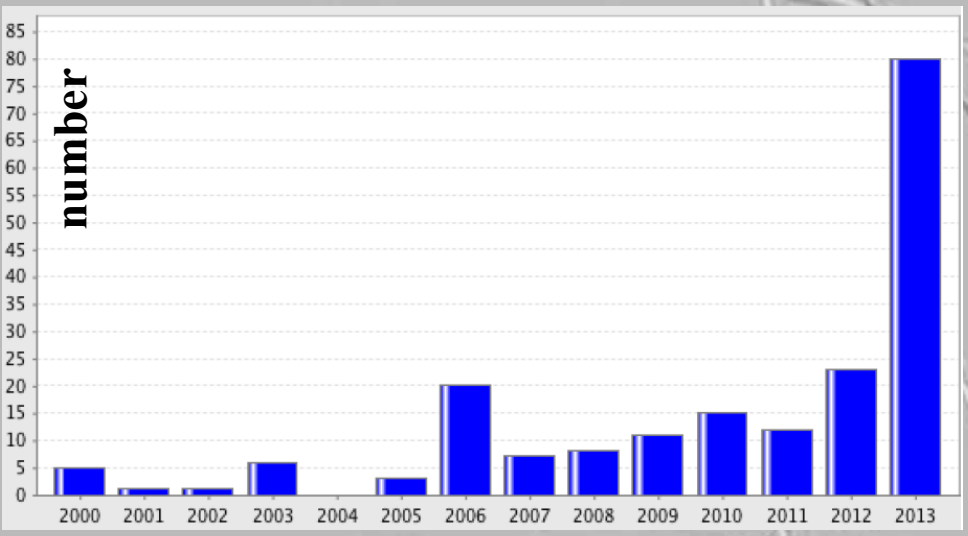


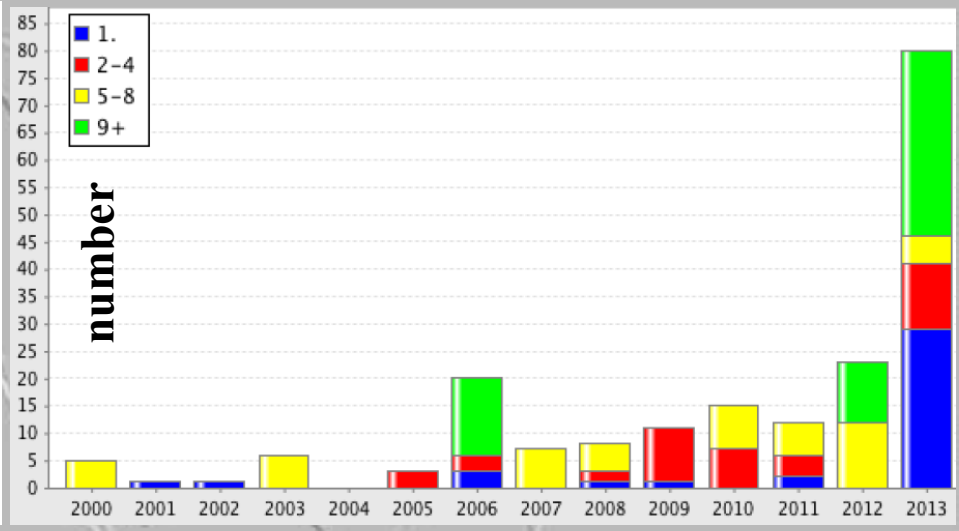
Example: In the experiments at the Air Force Research Lab, workers can build an entire "plug-and-play" satellite in 4 hours! Following a careful script, they start by connecting the spacecraft's six panels, which are hinged for easy access.[16]

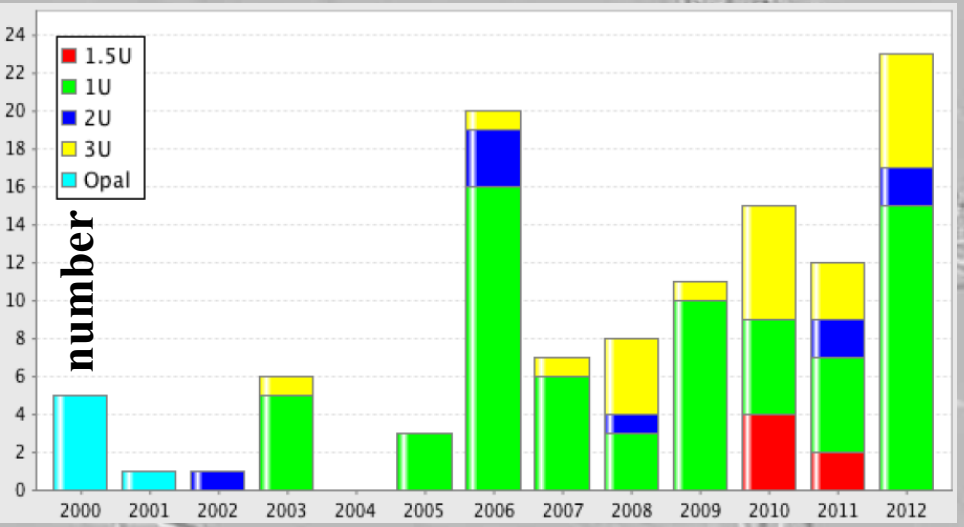
Statistical data for the on-orbit CubSat's

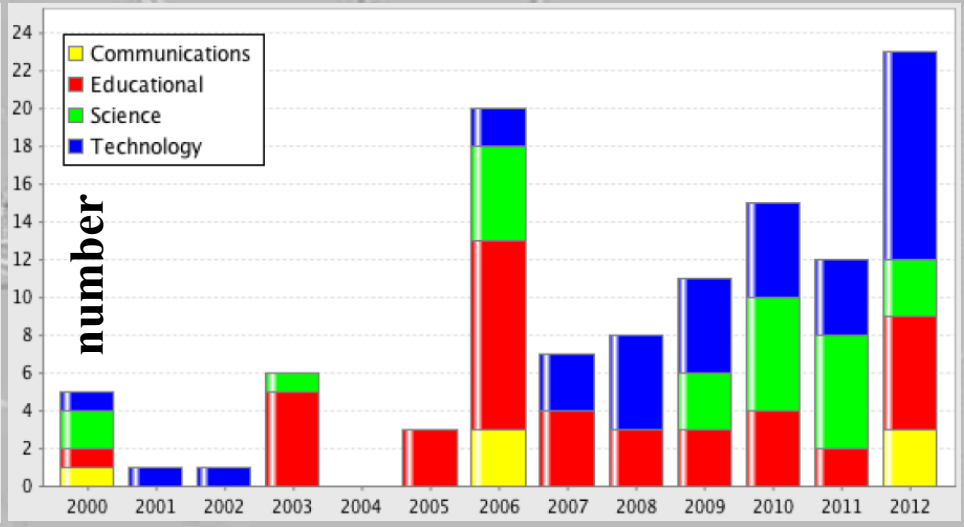


Statistics for CubeSat's (1)

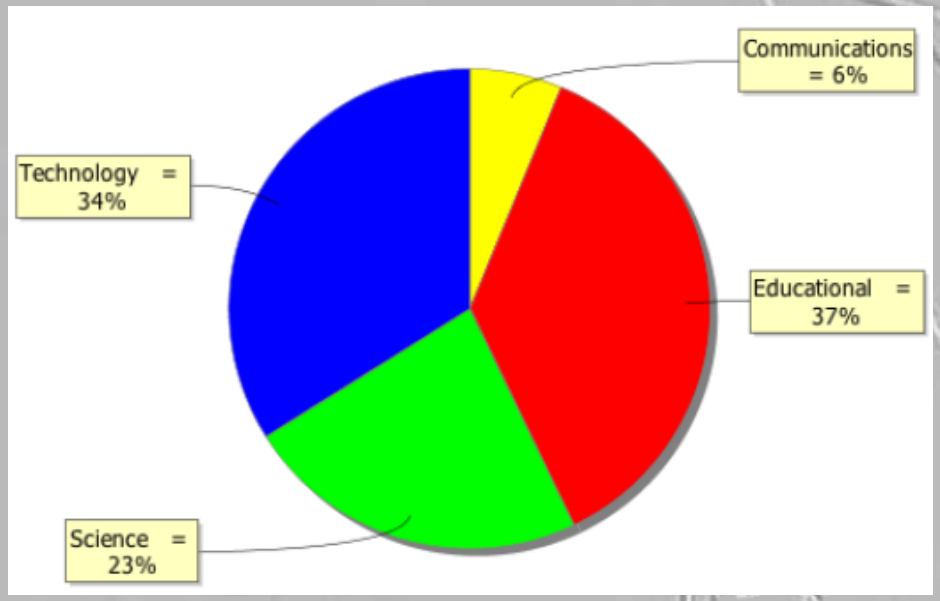


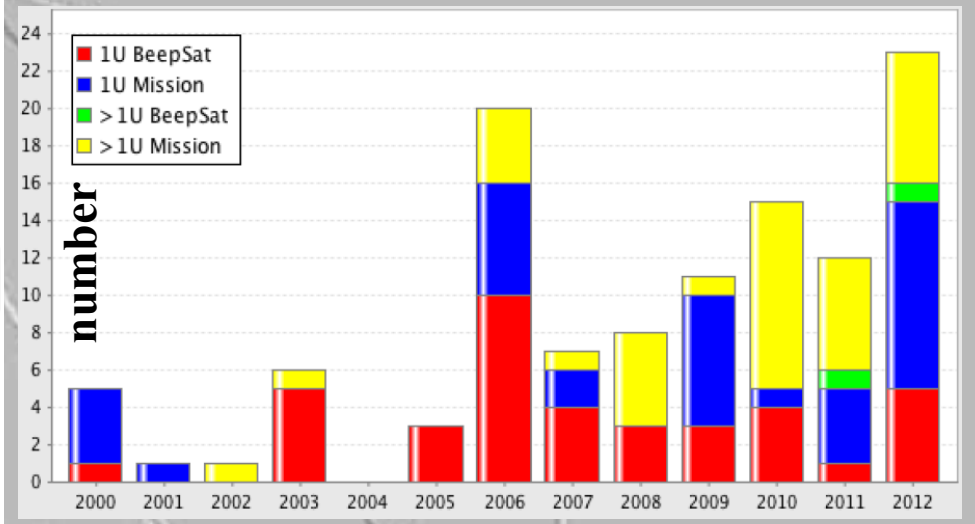


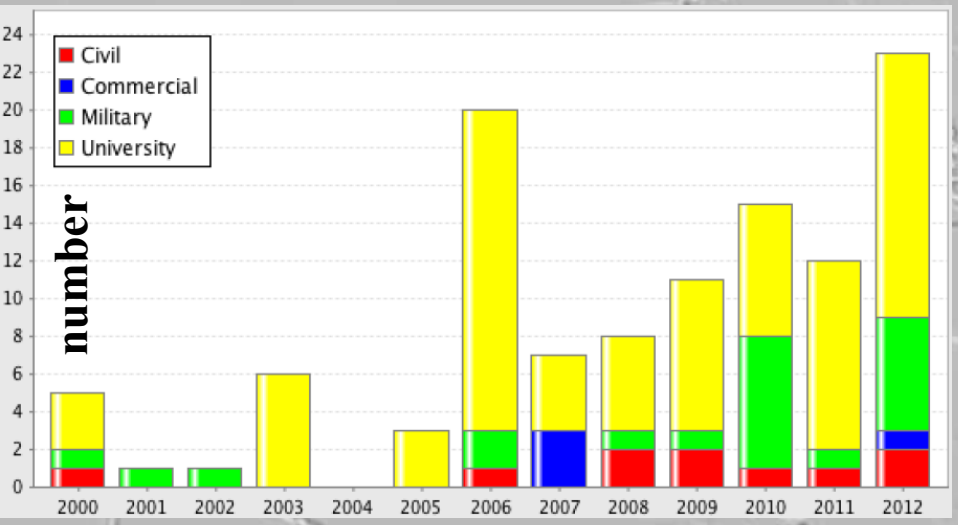


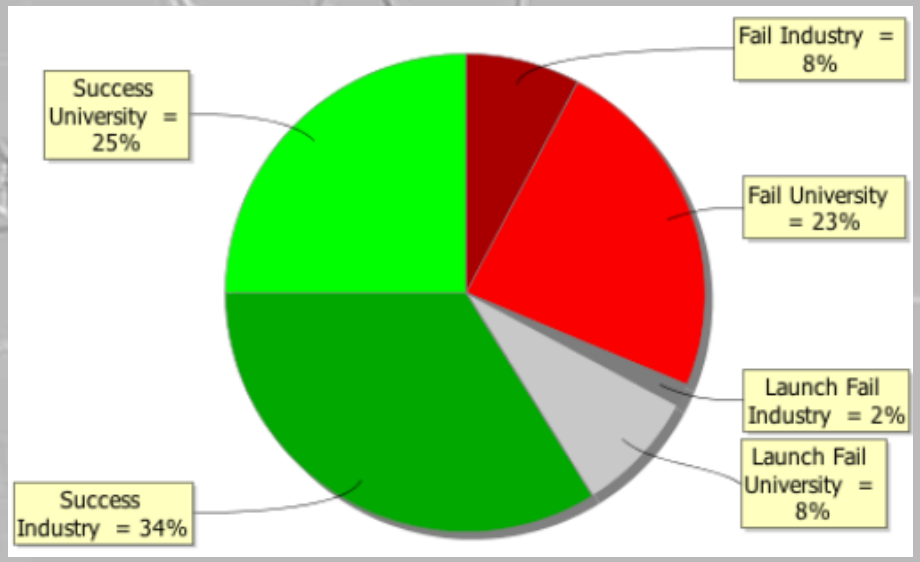


Statistics for CubeSat's (2)

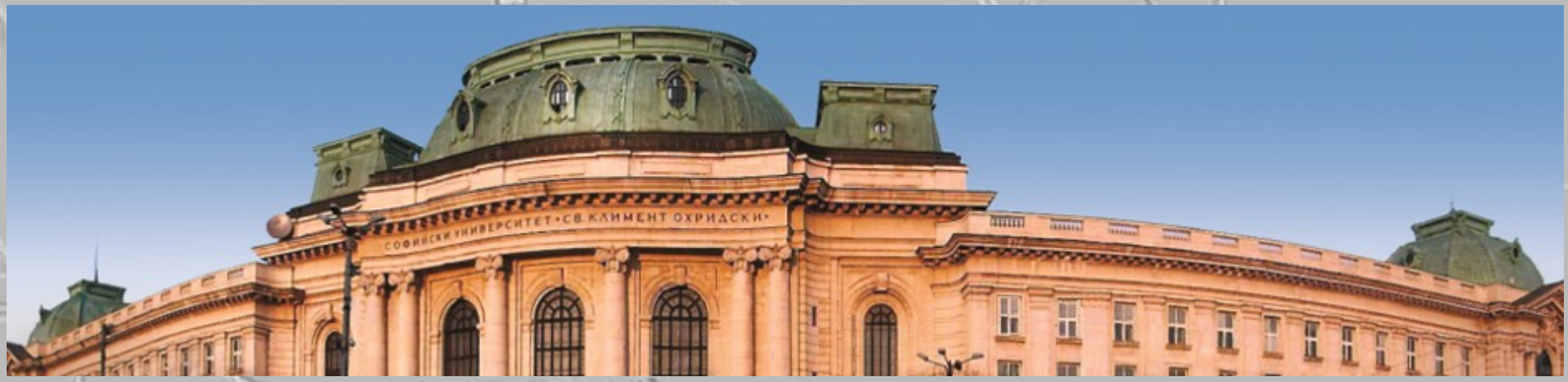








Aerospace engineering education in Sofia University

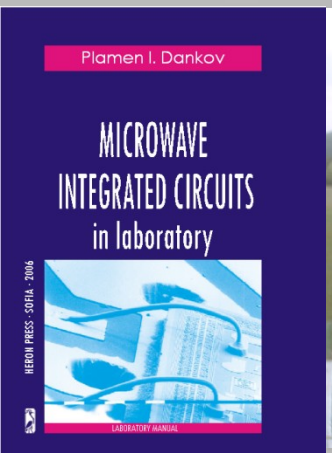


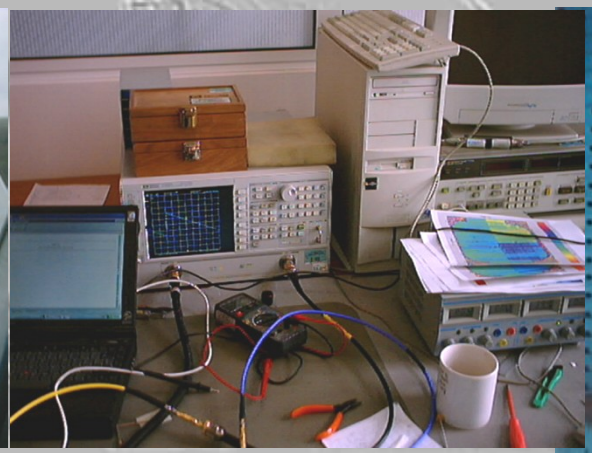
MSc program in Aerospace Engineering and Communications

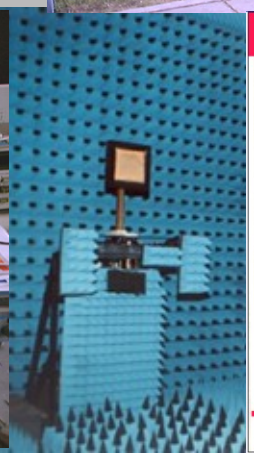
A new master program “Aerospace Engineering and Communications” (in Bulgarian; English or Russian) has been established to “fill up the vacuum” in the modern aerospace engineering in Bulgaria. The program has two modules:

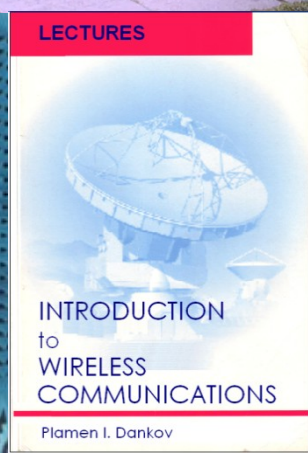
- Module 1. “Aerospace Engineering (small aerospace vehicles)”
- Module 2. “Wireless and Satellite Communications“

The idea is to combine these areas and to prepare specialists with MSc. degree in the both areas.









http://www.phys.uni-sofia.bg/~dankov/Master%20program%20ASE&C/CURRICULUM_Plan%202013&2014/asec-red-3_bg_2013_2014.pdf

Main Courses in the MSc. Program

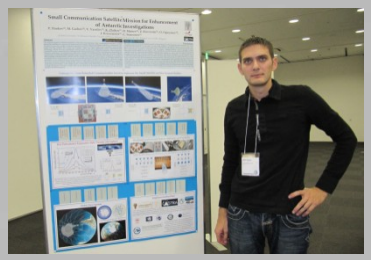
M1. Aerospace Engineering

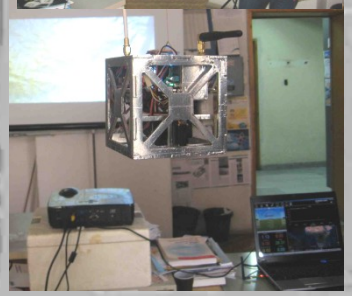
- Basic Principles of Mission Design with Small Aerospace Vehicles
- Aerodynamics and Orbital Dynamics
- Aerospace Control Systems
- Navigation and Telemetry of Small Aerospace Apparatus
- Photovoltaic Systems and Power Sources in Aerospace Apparatus
- Satellite Systems and Satellite information
- Space Physics
- Unmanned Aircrafts
- University Micro- and Nano-Satellites and Applications
- Software Tools for Aerospace Engineering
- Plasma and Plasma Propulsion Generators for Satellites
- Modern Electromagnetic Materials and Electronic Devices
- Other

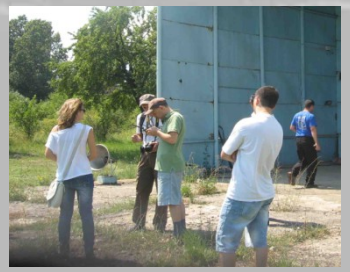
M2. Wireless and Satellite Communications

- Applied Electrodynamics
- Introduction to Wireless Communications
- Satellite Communications
- Computer Practice in Communication Networks and Protocols
- Microwave and Wireless Technique
- Modulations and Coding
- Integrated Circuits
- Antennas for Wireless Communications
- Operational Systems and Open-Source Applications in the Communications
- Security of the Communication Networks
- Communication and Information Systems for Data Transfer
- RFID
- Optical Networks and Devices
- Mobile Radio Channels
- Microwave Measurements
- Innovation Management

Our educational project and activities in the area of Small Satellites







Successful Participation in MIC2

In 2012 the Bulgarian team from Sofia University (including 14 students and 8 supervisors) was selected as a finalist from among 72 teams from 31 countries

The title was

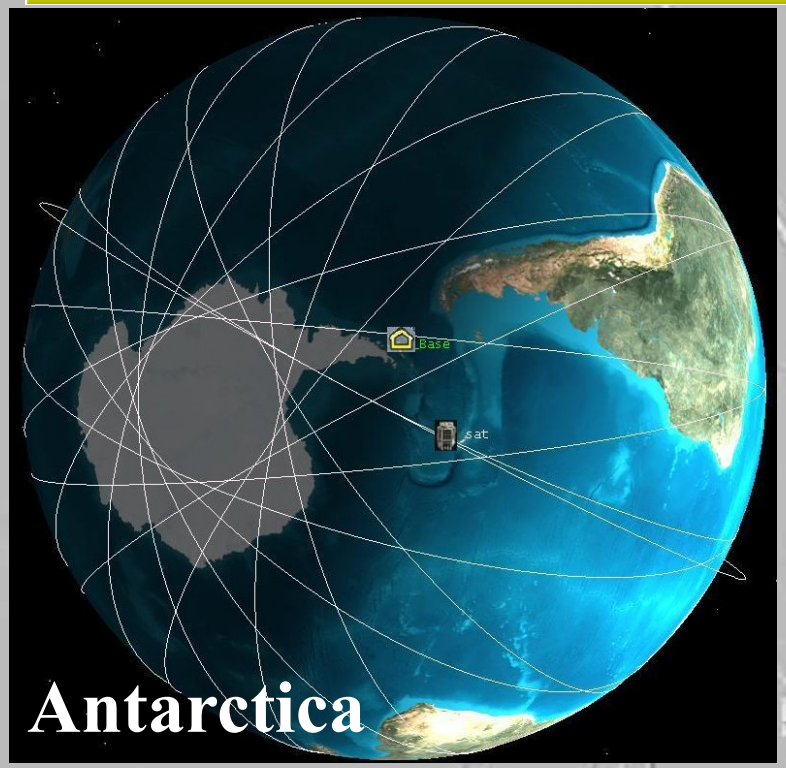
"Small Communication Satellite Mission for Enhancement of Antarctic Investigations".

Then a big invited paper was published with authors: P. Dankov, M. Gachev, Z. Kiss'ovski, I. Krassimirov, D. Mateev, N. Neshev, O. Ognyanov, C. Simeonov, V. Vassilev, K. Zlatkov

Communications with the Bulgarian Antarctic Base

One of its issues is in the field of information services for Antarctica, where communications are very difficult and there teams wait long to transmit data. Orbit may be set so as to pass there from daily or even several times a day, to collect data and to transmit it to Sofia and to other parts of the world in Europe, America, Asia, etc. So researchers can quickly receive feedback and respond as needed. The concept of satellites already been assessed as viable and promising in the International aerospace competition in Japan MIC2 (Nagoya, October 2012)

Non-Commercial Backhaul Communications with the Polar Region Using University Small Satellites



Our concept is to standardize and to improve the so-called "*communication function*" of the university small satellites in close-to-circular polar orbit in order to ensure backhaul communications with the Polar regions! (Is this possible in each case for each satellite?)

The 2nd Mission Idea Contest for Micro/Nano-satellite Utilization

UN/Japan Nano-Satellite Symposium

Nagoya, Japan

October 10-13, 2012

Bulgarian Small Satellite Project


КАПИТАЛ

Абонамент

ПОЛИТИКА И ИКОНОМИКА | БИЗНЕС | LIGHT | МУЛТИМЕДИЯ | ДЕБАТИ

НОВО (22) / КАПИТАЛ / КАПИТАЛ DAILY / К100

КАРИЕРИ

- КАЧЕСТВЕНИ ОБЯВИ ЗА РАБОТА, СЛАЖОВЕ И ОБУЧЕНИЯ
- КАРИЕРНИ КЛУБОВЕ ПО ИНТЕРЕСИ
- ТРУДОВО-ПРАВНИ КОНСУЛТАЦИИ
- МЕНИДЖМЪНТ СЪВЕТИ
- ПРОФИЛ НА РАБОТОДАТЕЛИ
- ИНТЕРВЮТА С УСПЕШНИ МЕНИДЖЪРИ

НОВО ДНЕВНИК ВИДЕО

// ПОЛИТИКА И ИКОНОМИКА

Първи стъпки в аерокосмическата индустрия

25 авг 2013, 17:40, 4536 прочитания

До две години България може да изпрати в Космоса малък спътник,

Mission Idea Contest (MIC) shared a link.

September 7

Good news!

We are pleased to share a wonderful news from Bulgaria. The small satellite mission described in Bulgaria's MIC2 semi-finalist paper won the Bulgarian government grant for the implementation!!

Please take a look at the followin... See More

Първи стъпки в аерокосмическата индустрия

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Within 2-3 years, Bulgaria could send into the space a small μ-satellite, which will cover the following three standard functions:

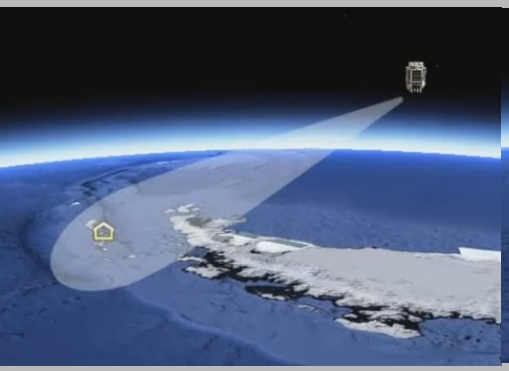
1) to collect images from the near space;
2) to transmit/receive data for backhaul communications and
3) for education purposes.

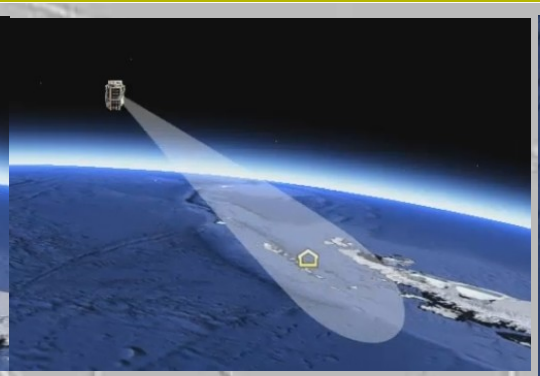
The developer is a group of companies and scientists together in an Aerospace cluster in Bulgaria

CASTRA (Aerospace Technology, Research and Applications).

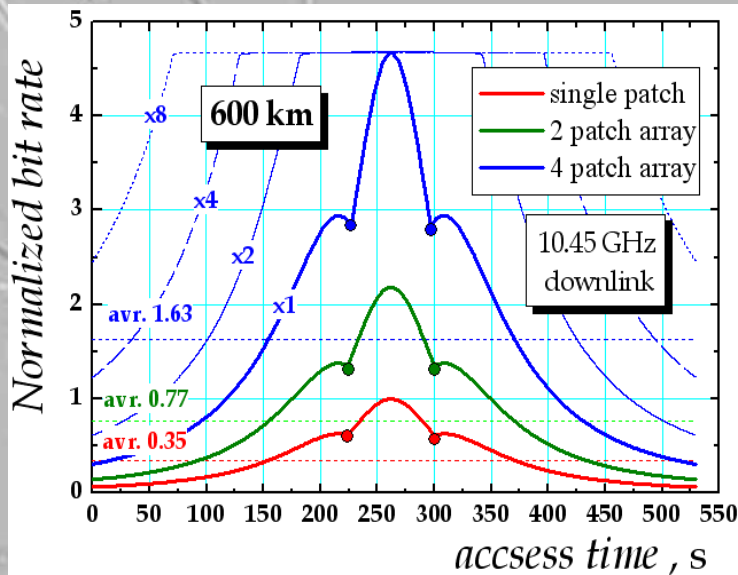
The project already received an official governmental support, being approved for funding under the European Operational Program "Competitiveness".

Educational project – 1) Extended Communication Sessions with Small Satellites



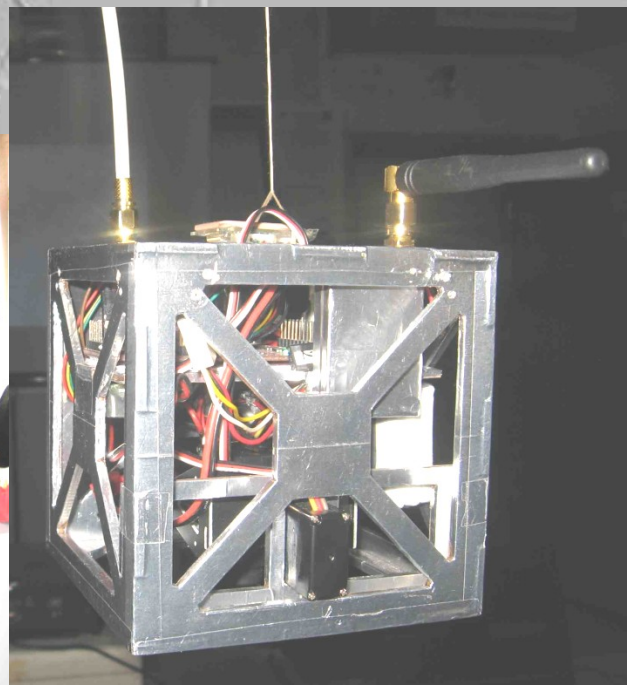



The communication session can be prolong using switchable on-board antenna panel with 5 faces. Thus, 4-5 communication sessions with one base station in Antarctica can be organized: 1 on “base” orbit and 2-3 on “side” orbits.



Educational project – 2) CubeSat Demonstrator

Two years ago a fully functional CubeSat model was created with dimensions 10*x*10*x*10 cm and weight several hundred grams. The author is our colleague eng. Ognyan Ognyanov. The aim of the project is mainly educational, but it possess the all main functionality of its category: telemetry, camera, data transfer, GPS positioning, gyroscope sensors for orientation according to the Earth magnetic field, solar panels, on-board computer, data storage, etc.



Educational project – 3) Online trace of meteorological balloons

The possibility to trace the uncontrolled flight of a meteorological balloon, to localize the object during the flight by the telemetry data and to localize the object after the cracking by the last received GPS coordinates is very similar to the possibility to trace the small satellites (like so-called CANSAT projects). Now the idea for the project has been used from the University Rescue Squad for training and education.

Educational project – 4) Amateur Student Space Center

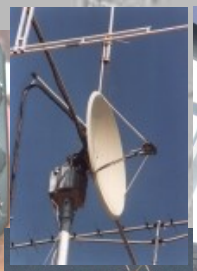
The idea is to build an amateur Student Space Center with 7 aims:

1) To trace small LEO satellites on orbit through the telemetry channels in VHF/ UHF band.

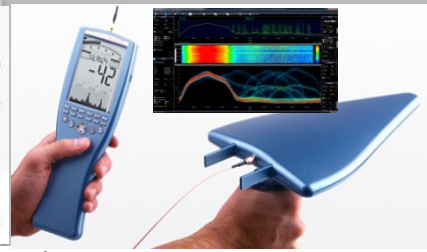
2) To receive data from the satellites through the existed communication channels (for example, in S band) and its processing, storage, display, documentation, exchange with the partners by land communication systems, etc.

3) Implementation of two-way connections (through uplink/downlink channels in the S and X band) for implementation of backhaul communications to remote stations – e.g. in Antarctica.

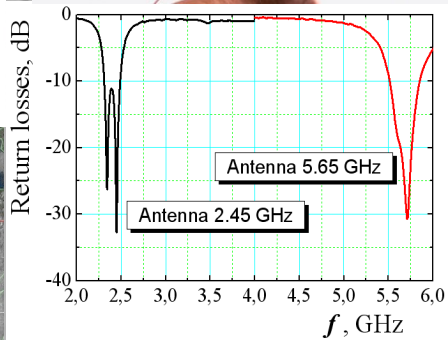
4) Education of students (in BSc. and MSc. degree) applying modern forms of education







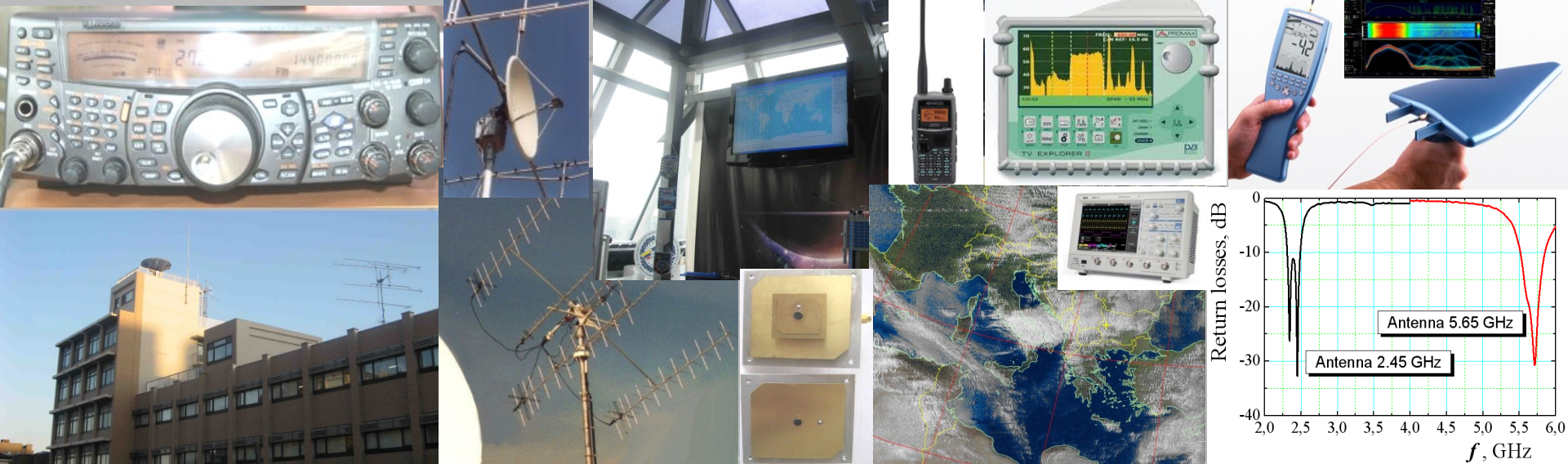


Educational project – 4) Amateur Student Space Center

5) Ensuring possibility for precise determination to the distance to satellites and other object by laser rangefinder, mounted near to the communication antennas. Ensuring possibility for on-line visual observation of the LEO satellites or other objects through small telescope with high-resolution camera, mounted near to the communication antennas.

6) Non-space applications of the Student Space Control Center – for tracking and high-speed communications with aerospace objects with nearer proximity to the Earth surface – meteorological balloons, unmanned vehicles, etc.

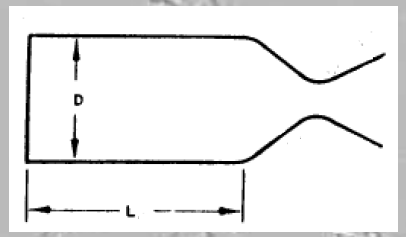
7) Communication and logistic support of the University Rescue Squad (URS) of Sofia University, which has long history and its team is very active.

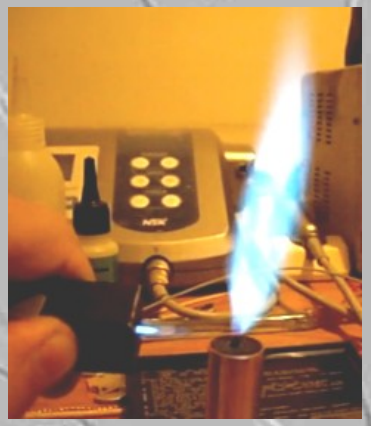


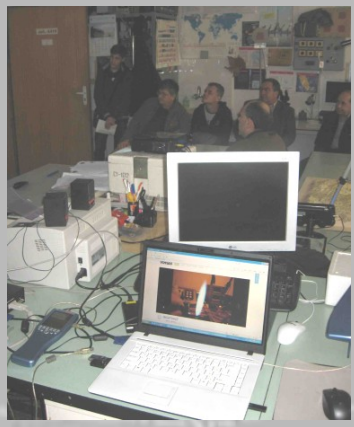
Educational project – 5) Small satellite thrusters

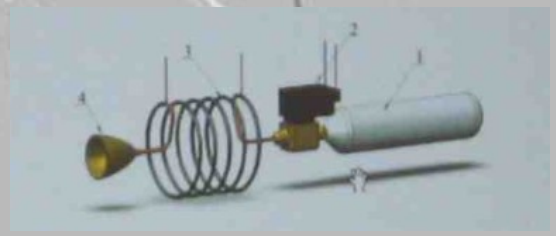
Two types of small satellite thruster have been investigated and developed:

1) plasma microwave source at atmospheric pressure; 2) chemical jet micro-thruster „Resistojet” .



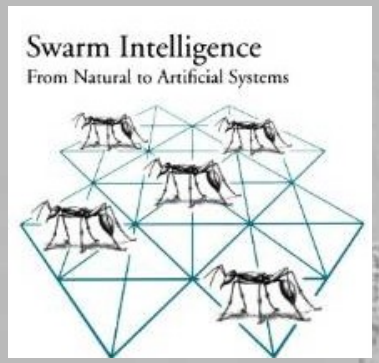


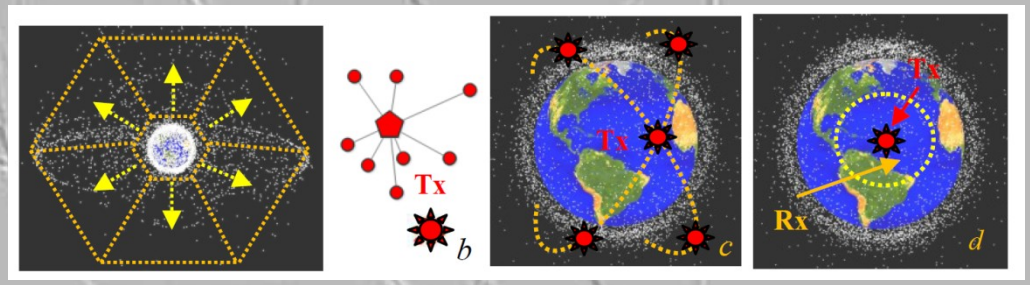


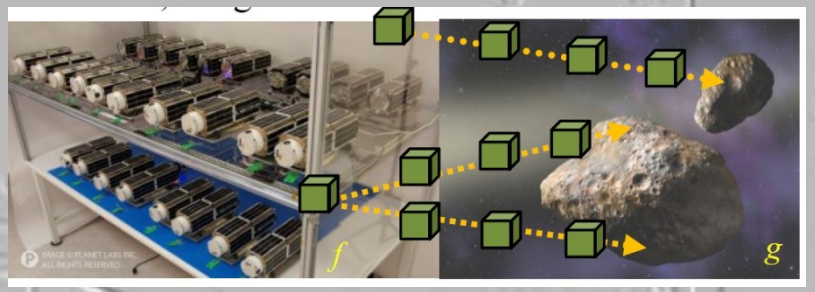


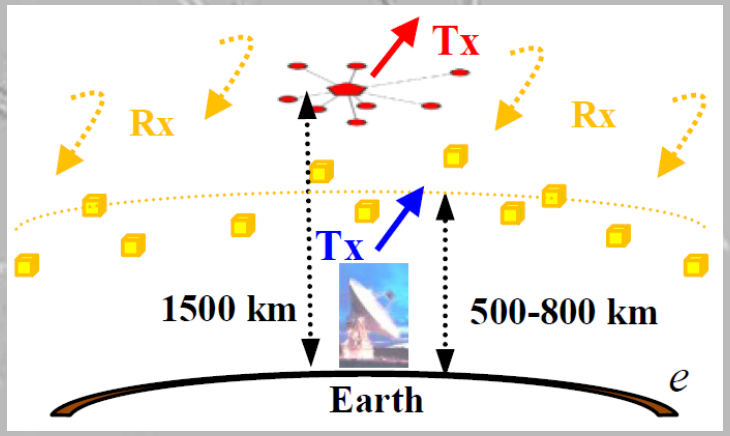
Educational project – 6) Small satellites and concept for the “swarm intelligence”

A combination between philosophy and technical ideas has been developed – the behavior of the small satellites like swarms and different application of this concept – “Swarm intelligence”. The topic is „Integrated Small Satellite Swarm Defense against Meteoroids“



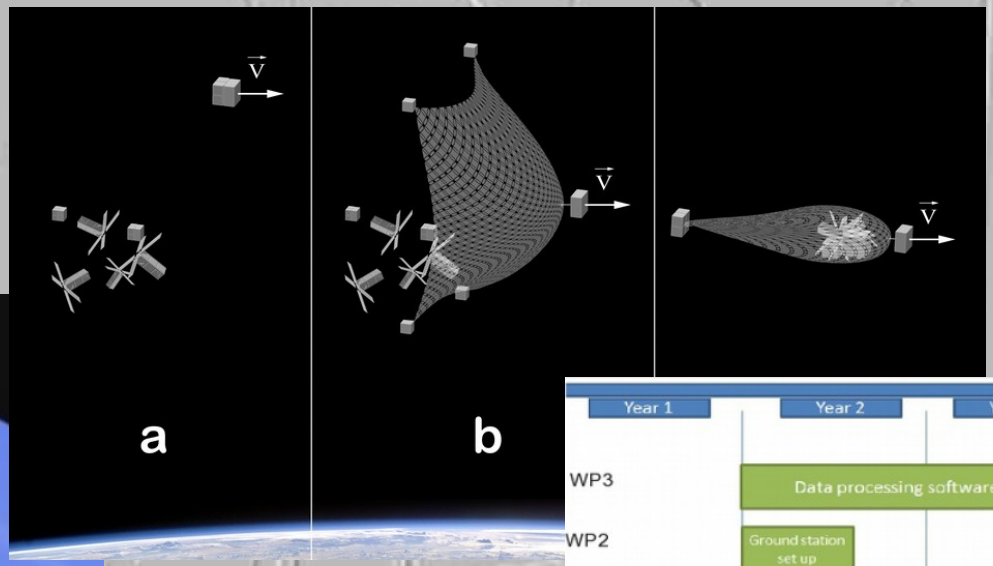


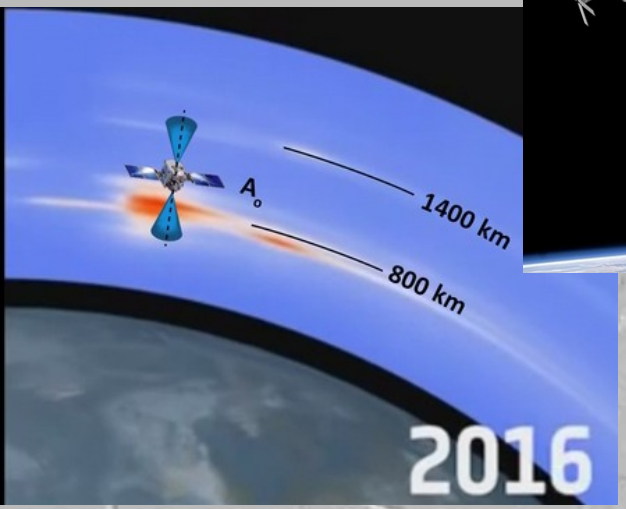


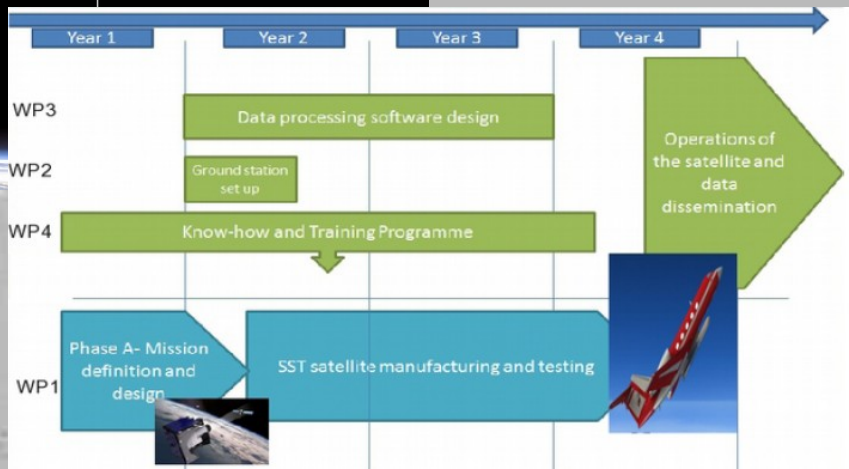


Educational project – 7) New concept for identifications, classification and aggregation of the space debris

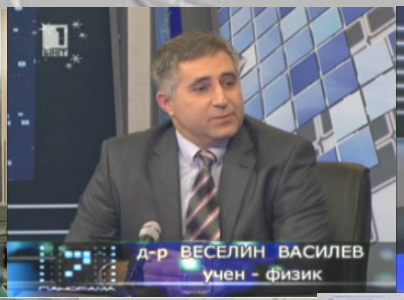
This is our last idea: active actions for treatment of the space debris. The topic is extremely actual and urgent. This is fully student development; our participation in the next Mission Idea Contest for small satellite utilization – MIC 4 in Istanbul – October 2016.

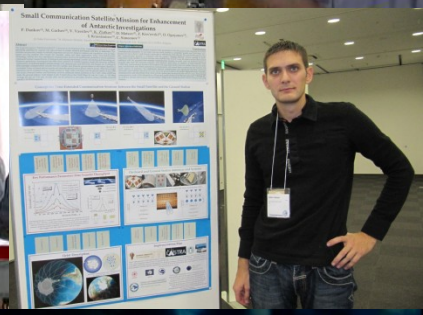


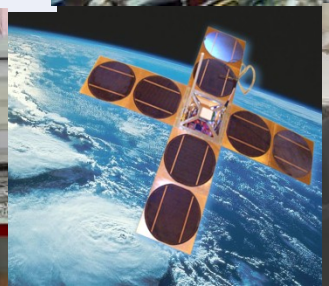




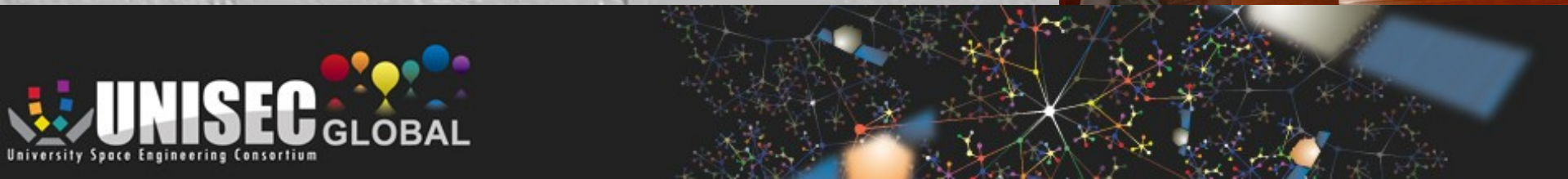
TV appearances







UNISEC Global – an University Space Engineering Consortium, hosted in Tokyo, Japan



UNISEC Global POC's

Africa


Arno Barnard


Zolana Joao


Smita Francis


Ayman


Manfred


Faith Karanja


Nnadih S.


Kamel

Oceania


Naomi

Asia


G.M. Tarekul


Thombi


Mengu Cho


In-Seuck


Tsolmon


Rogel Mari


Sultan Hasan


Low Kay Soon


Jyh-Ching


Sawat


A. Rüstem

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Jordi Puig-


Willy Ricardo


Blanca


Barbara


Hector Bedon

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Plamen I.


Klaus


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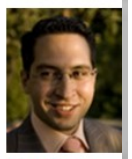
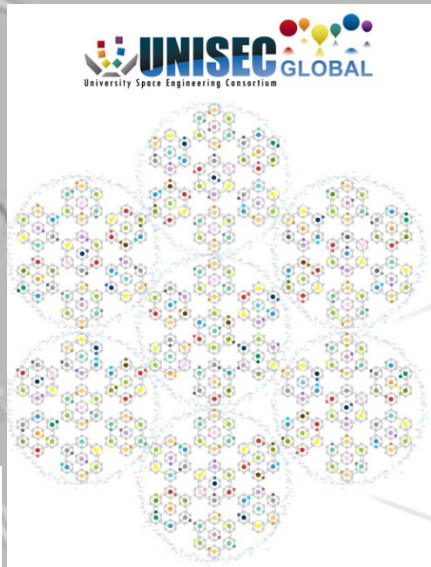

Cen Ozan



UNISEC GLOBAL
University Space Engineering Consortium

"By the end of 2020, let's create a world where university students can participate in practical space projects in more than 100 countries"

Vision of UNISEC-Global

ARABIC

الشروط المرجعية لتحالف جامعات هندسة الفضاء العالمي (UNISEC-Global)

BENGALI

ইউনিসেক-গ্লোবাল-এর আওতা ও কার্যপরিধি

নভেম্বর ২৪, ২০১৩

BULGARIAN

"До края на 2020 г., нека да създадем един свят, където студентите могат да участват в практически космически проекти в повече от 100 страни"

Визия на UNISEC-Global

CHINESE

參考UNISEC - 環球條款

2013年11月24日

JAPANESE

リファレンスのUNISEC-Globalの利用規約

2013年11月24日

KOREAN

참조의 UNISEC - 글로벌 약관

2013년 11월 24일

Visión 2020-100

Hacia finales del 2020 tendremos un mundo en el que los estudiantes universitarios podrán participar en proyectos espaciales prácticos en más de 100 países.

رؤية 2020-100

دعنا نصنع سوياً عالماً يستطيع فيه طلبة الجامعة فى أكثر من 100دولة المشاركة فى مشاريع بحثية تطبيقية بحلول عام 2020

VISÃO 2020-100

Até o ano de 2020 vamos criar um mundo, onde estudantes universitários poderão participar de projectos espaciais práticos em mais de 100 países.

Vision 2020-100

Bis Ende 2020 wollen wir es schaffen, dass in mehr als 100 Ländern weltweit Studenten an praktischen Raumfahrtprojekten teilnehmen können.

зрение 2020-100

К окончанию 2020 года давайте создадим мир, в котором студентыуниверситетов смогут участвовать в реальных космических проектах вболее чем 100 странах

Vizyon 2020-100

2020 yılı sonundan önce 100 den fazla ülkede Üniversiteöğrencilerinin katılabileceği uygulamalı ve gerçekçi uzay projelerininolduğu bir dünya yaratalım

রূপকল্প ২০২০-১০০

"চলুন আমরা ২০২০ সালের মধ্যে এমন একটি বিশ্ব গড়ি, যেখানে এক শ'রও বেশী দেশে বিশ্ববিদ্যালয় শিক্ষার্থীগন ব্যবহারিক মহাকাশ প্রকল্পে অংশগ্রহণ করতে পারবেন।"

Pangitain 2020-100

Sa pagtapos ng taong 2020, tayo'y lumikha ng isang mundo kung saan angmga mag-aaral sa mga pamantasan sa humigit na isandaang bansa aymaaring makilahok sa mga makabuluhang proyektong pangkalawakan.


Thank you for
the attention!