



Space Sector Activities in Bulgaria Opportunities for R&D and Business Collaboration through developing small satellite projects

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**United Nations/Brazil Symposium on Basic Space Technology
"Creating Novel Opportunities with Small Satellite Space
Missions"**

Natal, Brazil, 11-14 September 2018

OUTLINE

- **Space Exploration Governance**
- Bulgarian space activities
- Space @ Business
- An example for student involvement

Bulgarian space activities and EU

Lisbon Treaty & Strategy

European Parliament Resolution on the European Space policy
11/2008

European Commission COM(2016) 705 Space Strategy for Europe
26/10/2016

European Parliament Resolution № 9898/18 on the European Space Program
Q4/2018

European Space policy for space exploration and transfer of results to the benefit of society and the citizens

European Space Program

European Space Agency AND the European Union Agency for the Space Program

BULGARIAN Space Policy (TBD)

National program for space activities – R&D and industry applications (TBD)

National administration and executive body coordinating space matters- research, industrial transfers and applications (NA)

Academia

NGO's and communities

Government establishments

Business

The Successful integration of Bulgaria in the EU implies Bulgarian participation in the definition of the EU space policy and the EU executive bodies related to fulfillment of the Lisbon Treaty concerning space exploration and related goals

Brussels, 26.10.2016
COM(2016) 705 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE AND THE COMMITTEE OF THE REGIONS

Space Strategy for Europe

European Space Strategy priorities:

*Space exploration is VERY
important for Europe*

MAXIMISING THE BENEFITS OF SPACE FOR SOCIETY

- ENCOURAGING THE UPTAKE OF SPACE SERVICES AND DATA
- ADVANCING THE EU SPACE PROGRAMMES AND MEETING NEW USER NEEDS

FOSTERING A GLOBALLY COMPETITIVE AND INNOVATIVE EUROPEAN SPACE SECTOR

- SUPPORTING RESEARCH AND INNOVATION AND DEVELOPMENT OF SKILLS
- FOSTERING ENTREPRENEURSHIP AND NEW BUSINESS OPPORTUNITIES

REINFORCING EUROPE'S AUTONOMY IN ACCESSING AND USING SPACE IN A SECURE AND SAFE ENVIRONMENT

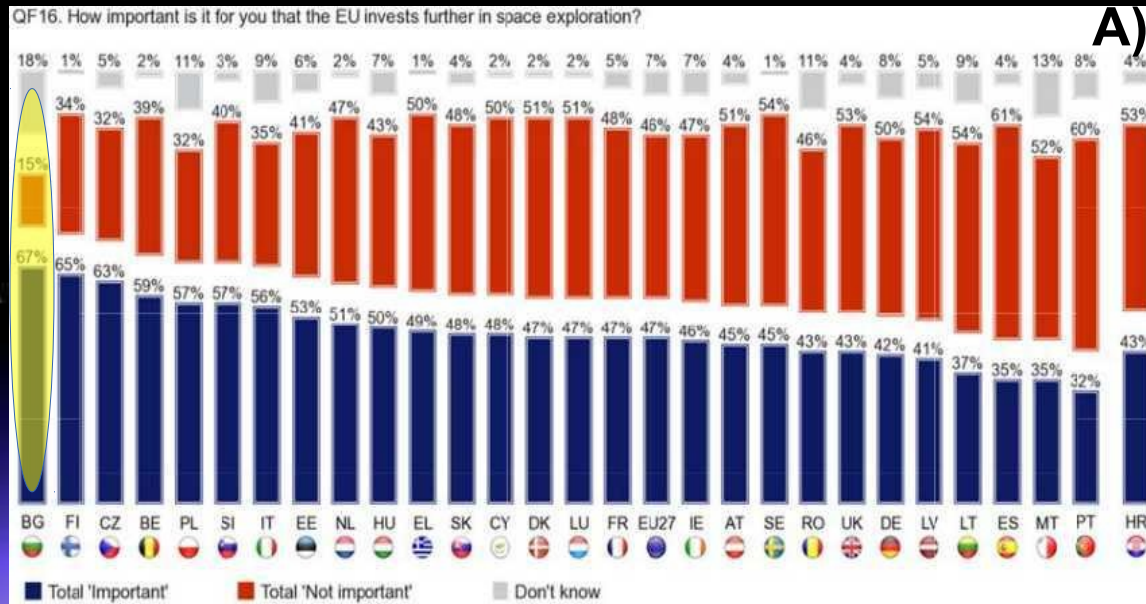
- MAINTAINING EUROPE'S AUTONOMOUS ACCESS TO SPACE
- ENSURING ACCESS TO RADIO FREQUENCY SPECTRUM
- ENSURING THE PROTECTION AND RESILIENCE OF CRITICAL EUROPEAN
SPACE INFRASTRUCTURE
- REINFORCING SYNERGIES BETWEEN CIVIL AND SECURITY SPACE ACTIVITIES

STRENGTHENING EUROPE'S ROLE AS A GLOBAL ACTOR AND PROMOTING INTERNATIONAL COOPERATION ENSURING EFFECTIVE DELIVERY

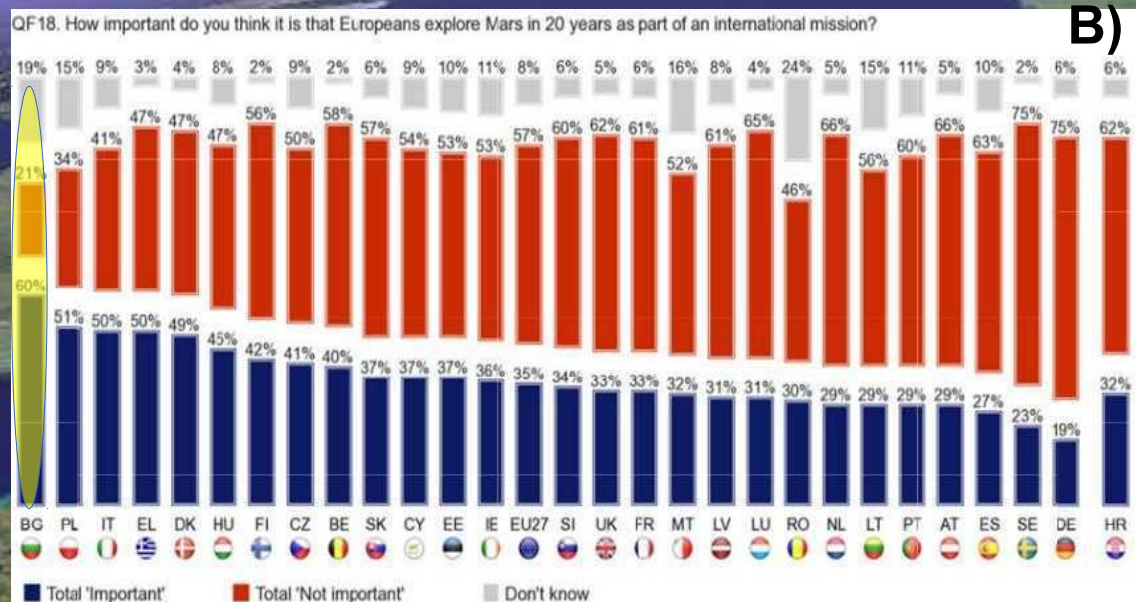
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Bulgarian Public Support for Space



The public opinion in Bulgaria supports the most in the EU the increase of the EU investments in space exploration (see chart A)

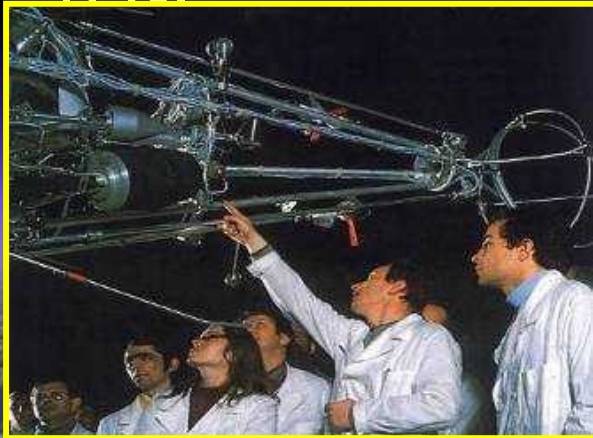


The public opinion in Bulgaria supports the most in the EU the implementation of long-term large scale space programs e.g. mission to Mars (see chart B)

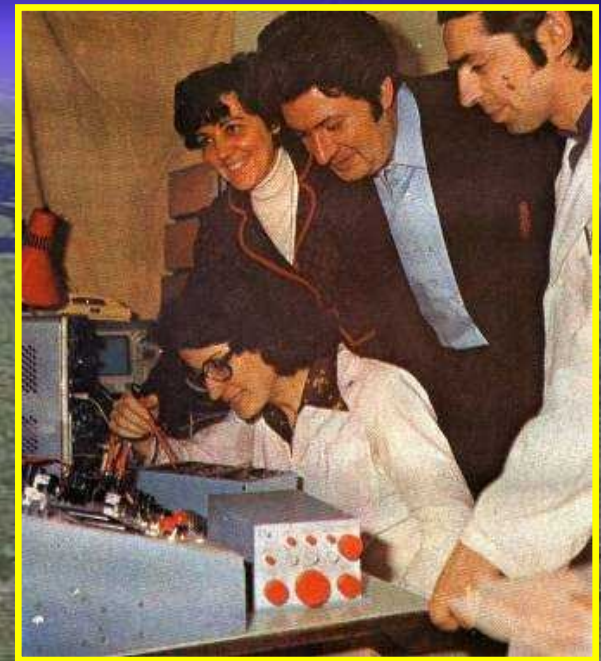
EU survey analysis
(‘Eurobarometer’, 2013)

Bulgaria's Space Heritage

- The first participation of Bulgarian scientists in space research started in 1969;
- 1967-1976 participation in the **INTERCOSMOS** Programme, preparing experiments for the satellites "**INTERCOSMOS - 8**" (IK - 8, 1972), IK - 12, IK-14, IK-19 and the heavy geophysical rockets VERTICAL - 3, 4, 6, 7, 10.



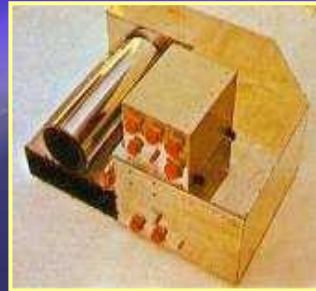
In 1972, after the launch of its first R&D Payload P-1 on Intercosmos-8, Bulgaria became the 18-th space country



Ref: Bulgarian population : 7 Million, compared to the one of the state of Massachusetts

Bulgaria's Space Heritage – success stories

Two complete satellite programs: “BULGARIA 1300-I”
and “METEOR-PRIRODA”



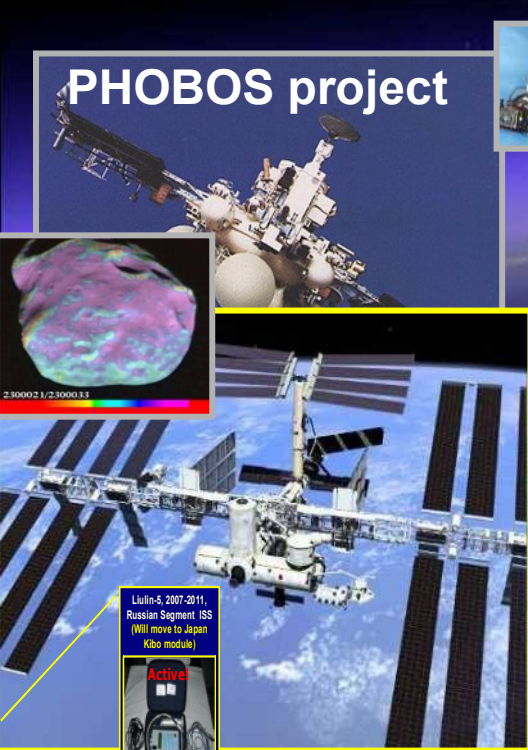
- BULGARIA 1300- for studies in the field of space



Bulgaria's Space Heritage – success stories

Strong Bulgarian hardware and methodology participation in a numerous un-manned and manned space missions aboard Russian, US, European, Indian and Japanese space vehicles, providing scientific instrumentation, data processing, methodologies and other capabilities.. Some examples:

PHOBOS project



NEUROLAB project aboard MIR



SVET Space Greenhouse onboard the MIR SS



EXPOSE-R

R3DR instrument as part of ESA EXPOSE-R facility is working at the Russian segment of ISS since March 2009

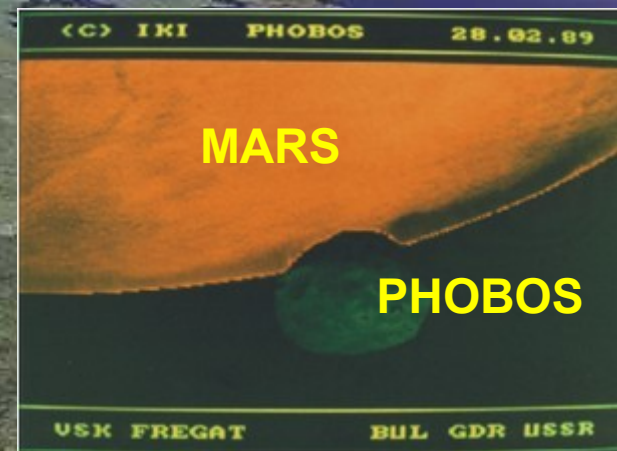
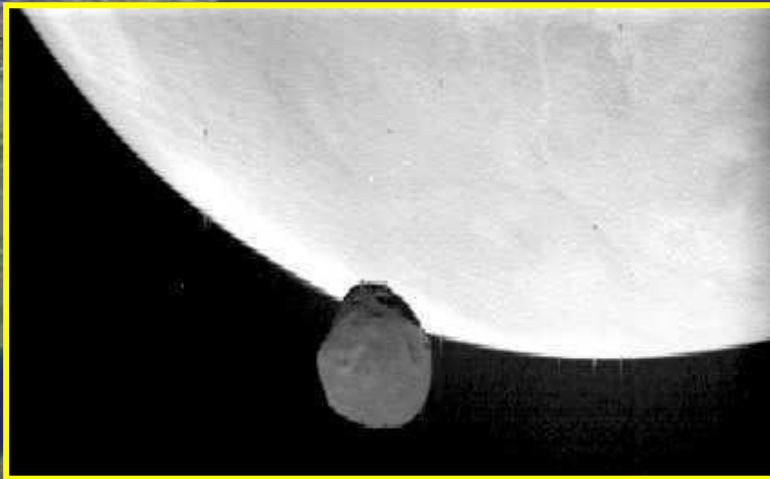
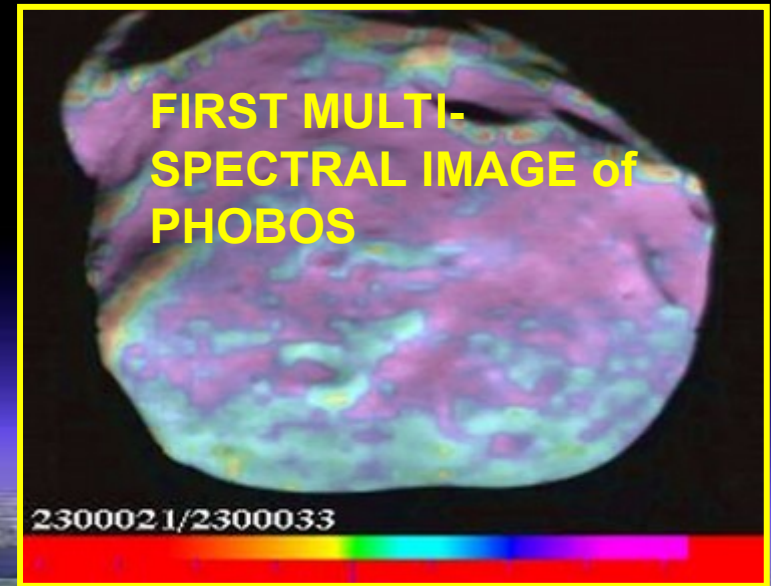
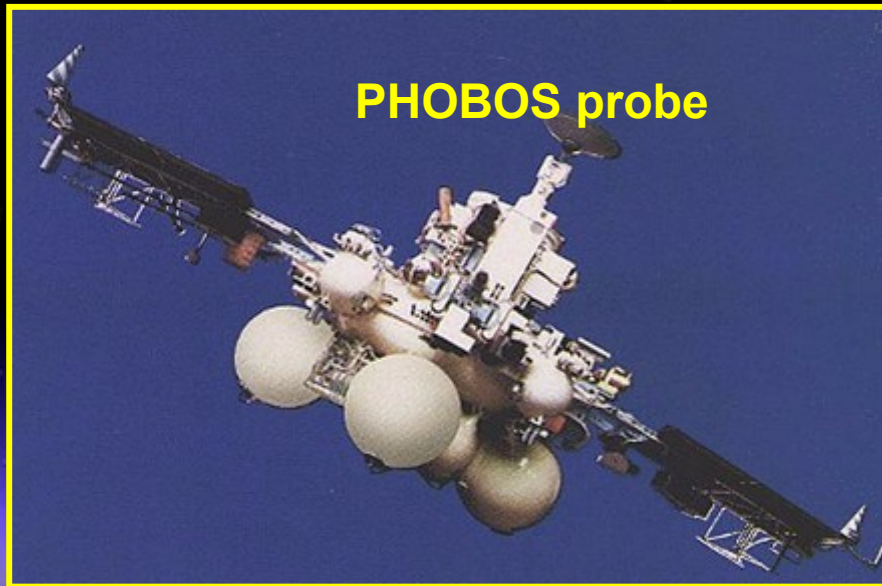


RADOM

Ljlin 5 personal doseimeters ACTIVE on ISS since 2005

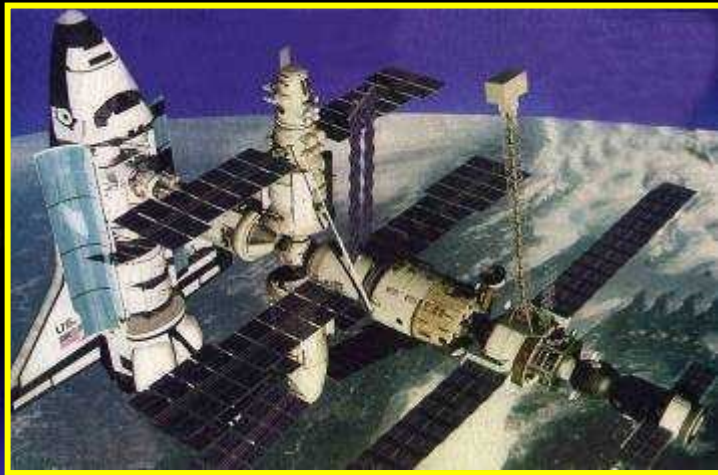
RADOM instrument on the Indian first Moon satellite - Chandrayaan-1

Bulgaria's Space Heritage – success stories



In 1989 Bulgarian research groups took part in the design of the FREGAT video spectrometric complex of the USSR led MARS-PHOBO program

Bulgaria's Space Heritage – the SVET Space Greenhouse onboard the MIR Orbital Station



Russian cosmonaut Sergey Zalyotin from the last 28th MIR OS crew samples plants of *Brassica rapa* variety grown onboard and tastes its flavour quality for the first time



The Bulgarian SVET Space Greenhouse (SG) mounted in the Crystal module was the only automatic plant growth facility flown onboard the MIR OS in the period 1990-2001



USA astronaut Shannon Lucid carried out wheat experiment (*Super Dwarf*) in 1996 – the heads were empty, without seeds, because of the gas ethylene in the atmosphere

Liulin-5 dosimetric telescope is a part of Matroska-R facility. The telescope is jointly developed with IMBP, Moscow Russia. Matroska experiment is a mutual between ESA and Russia and was launched toward ISS in June 2007. In 2011 was moved to Japan Kibo module

Active now!



Weight 0.57 kg; P = 330 mW



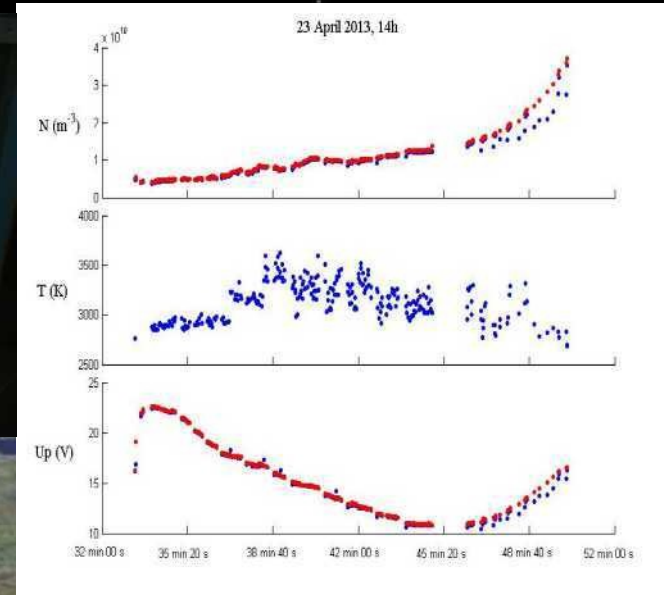
Liulin-5 in the spherical phantom on PIRS module of ISS



RADOM instrument on the Indian first Moon satellite - Chandrayaan-1

SUCCESSFUL STORIES

ISS plasma charging study – OBSTANOVKA Experiment- on-going



The ISS body potential varies and creates undesired voltage drops (there is no ‘Grounding’ in space !)

SUCCESSFUL STORIES

TWO Bulgarian R&D cosmonaut space flight programs implemented – 1979, 1988

Developed unique experience and infrastructure in program management, developed numerous spaceborn and ground instruments and infrastructure, fundamental sciences and other related areas

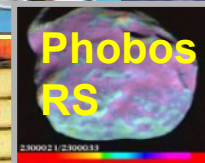


Tele-medicine apparatus
personal dose meters

RADOM



Space food



Phobos
RS



Space station base
green house

NEW high-tech SME potential

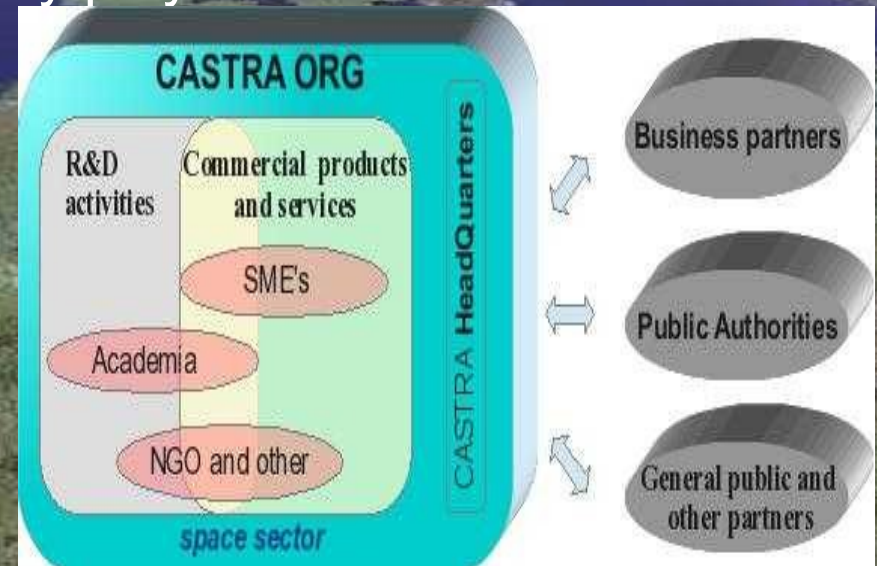
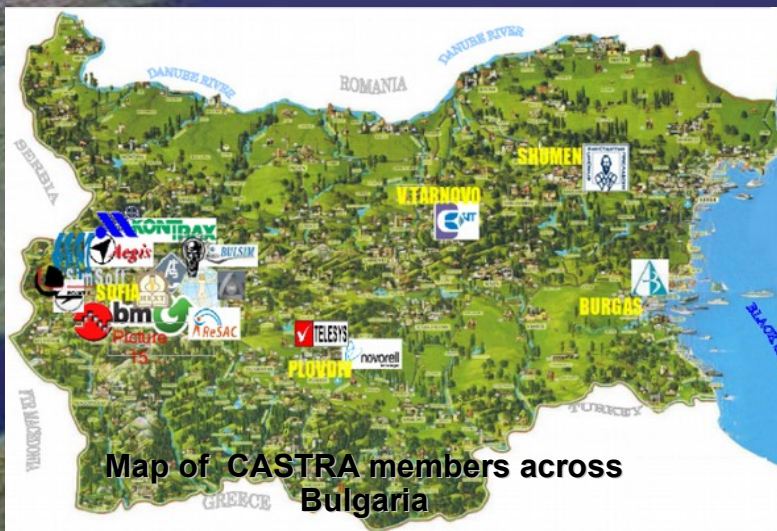
Electronics, IC design, automation, robotics, UAV systems, high-speed satellite communications, software and embedded systems and other.



What is CASTRA?

CASTRA is an independent industry-driven consortia (cluster) of high-tech SME's, academic institutions and other interested stakeholders with expertise and capacity to jointly develop technologies, products and services in the aerospace domain and its applications serving society.

CASTRA's vision is to promote the research, innovation, technology and business developments in the aerospace sector to the benefit of society and to act as a major industry player.



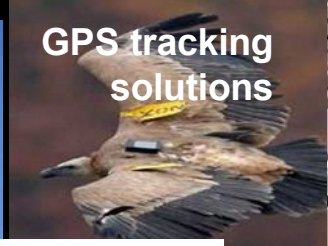
“Together we are stronger” - Bulgaria's strategy to success

CASTRA's technology R&D and product expertise examples

Digital electronic systems



GPS tracking solutions



Embedded IoT systems



EMI/EMP protection equipment

Solar electromagnetic storm

Induced electrical discharges and over-voltages

EMP - phase E1 and E3 of Nuclear explosion

50,000V/m for 200ns - E1
2kV for 20-300nsec - E3

3-12 GHz - 10kW
500ns pulses - 10MW



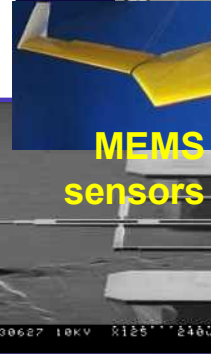
ICT & BigData for space app

System on a RADIATION HARD ASIC Design & Test

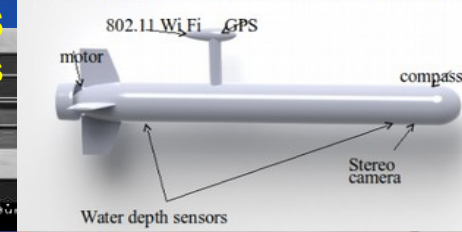
Virtual reality and REAL GAMES development



UAV systems



Autonomous Underwater Vehicle



RF design



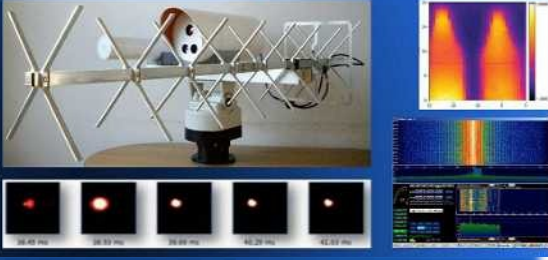
MW Antennas



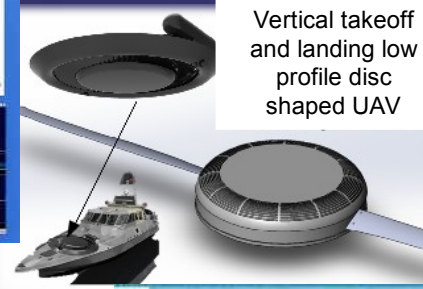
carbon fiber products for automotive, space, robotics, consumer

Dron detection and counter measures system

Visual-MWIR camera, laser range finder, spectral analyzer, ja



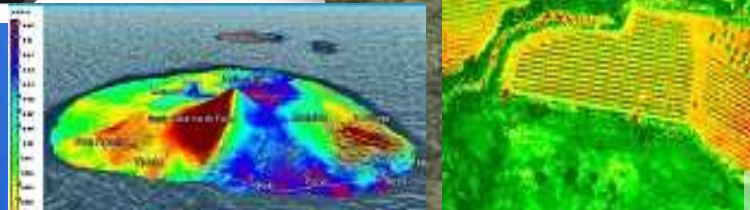
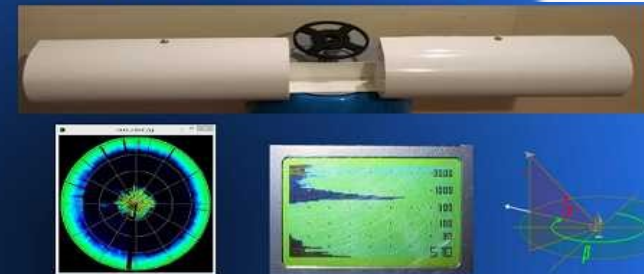
Vertical takeoff and landing low profile disc shaped UAV



Jet UAV shooting targets



FMCW panoramic radar for drones



Multispectral and SAR data processing

Design & manufacturing of precision equipment and high-energy systems



OUTLINE

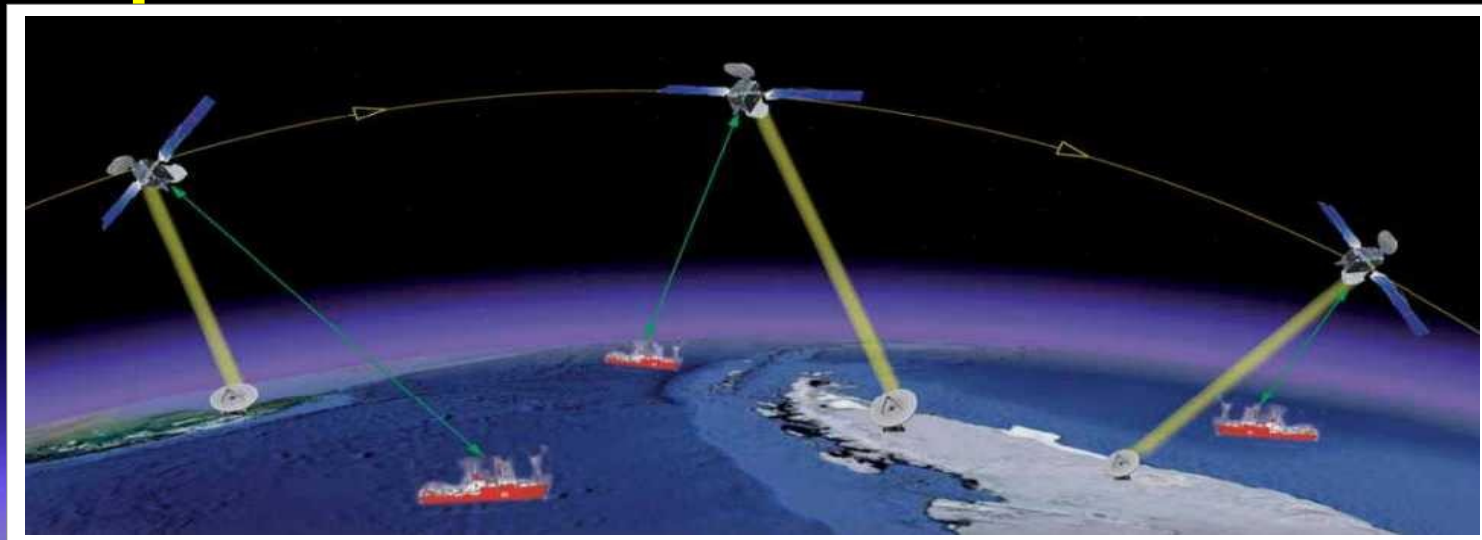
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SMALL SATELLITE APPLICATIONS OFFER GREAT POTENTIAL FOR BUSINESS

NANO AND MICROSATELLITE MARKET SIZE, BY APPLICATIONS, 2014-2019 (\$MILLION)

Application	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
Communication	100.2	127.7	155.5	177.8	193.8	206.8	15.6%
Earth Observation and Remote Sensing	81.1	132.3	206.6	301.5	422.7	555.8	47.0%
Scientific Research	202.7	261.0	323.3	379.2	425.2	455.2	17.6%
Biological Experiments	27.3	40.9	55.5	69.2	76.7	84.1	25.2%
Technology demonstration and verification	228.6	274.8	320.5	357.0	384.0	402.3	12.0%
Academic Training	31.9	44.8	60.7	78.5	96.1	106.1	27.2%
Reconnaissance	30.7	39.2	48.5	58.8	68.9	76.9	20.2%
Total	702.4	920.8	1170.7	1421.9	1667.4	1887.1	21.9%

Small LEO Satellite ICT system for high-speed data communication services



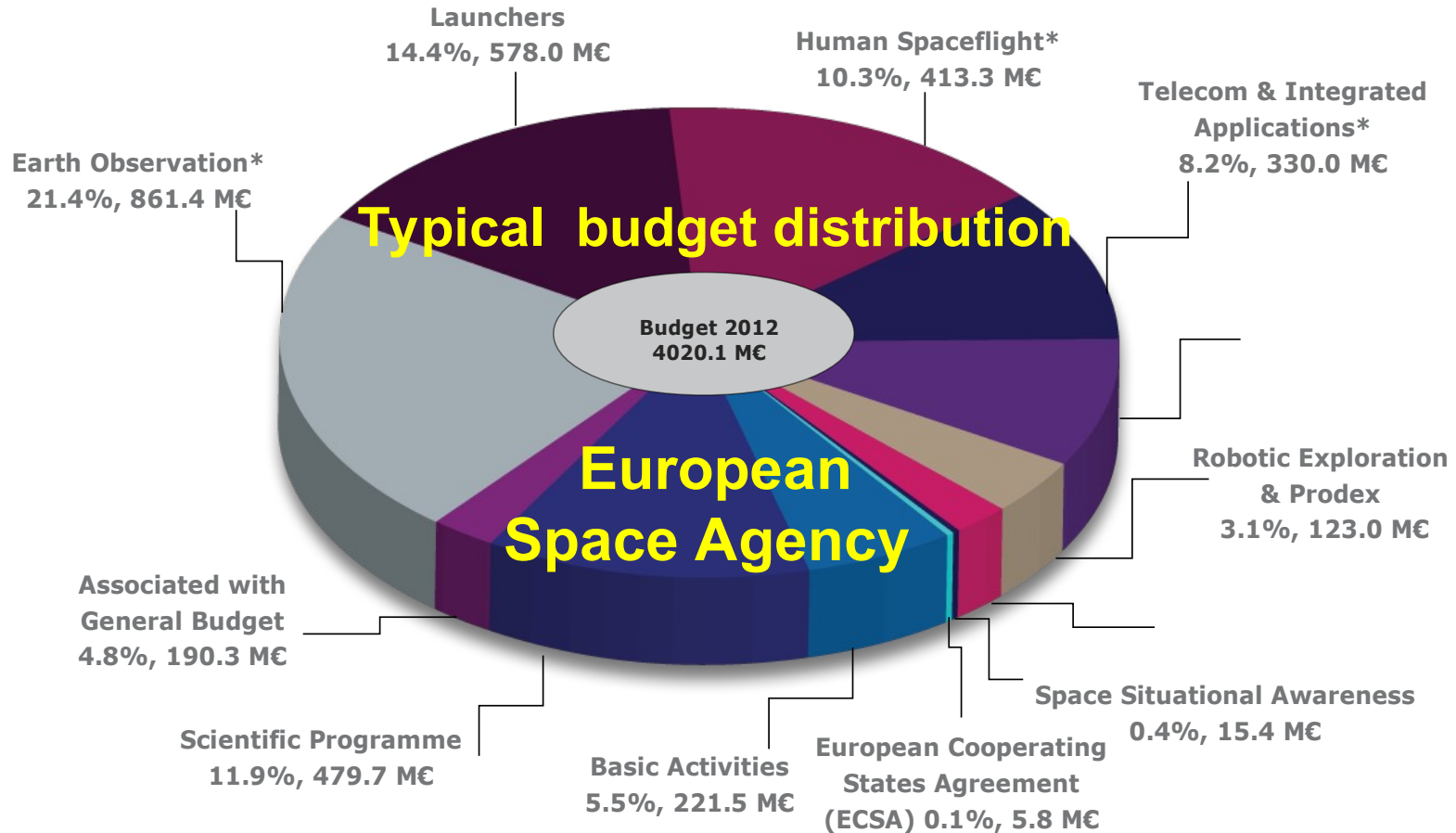
FINANCIAL RATIOS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Current Ratio	0.00	0.00	3.15	3.84	4.14	4.65	4.96
Quick Ratio	577.21	2.25	16.14	19.16	19.80	52.30	87.68
Debts / Equity Ratio	67.00%	97%	51%	24%	5%	1%	1%
RoA	61%	-25%	5%	14%	20%	23%	21%
RoE	104%	-52%	8%	18%	20%	22%	20%
Profit margin , %	174% (on the condition of a possible EU grant co-investment)		19%	40.00%	48%	58%	59%

**Space sector business typically offers over 400 %
Return on Investments over a typical 5 year
investment cycle**

SME's can benefit a lot from participating in ESA's R&D&I activities in various technology areas

M€: Million Euro

*includes Third Party Activities



Space Industry offers the highest value added in Europe and has a typical ROI of 400% over 4-6 years term

SOME POSSIBILITIES FOR FUNDING OF joint R&D and Business Projects

- EU's H2020 Program
- INVESTMENT FUNDS (EU, Bulgaria, worldwide)



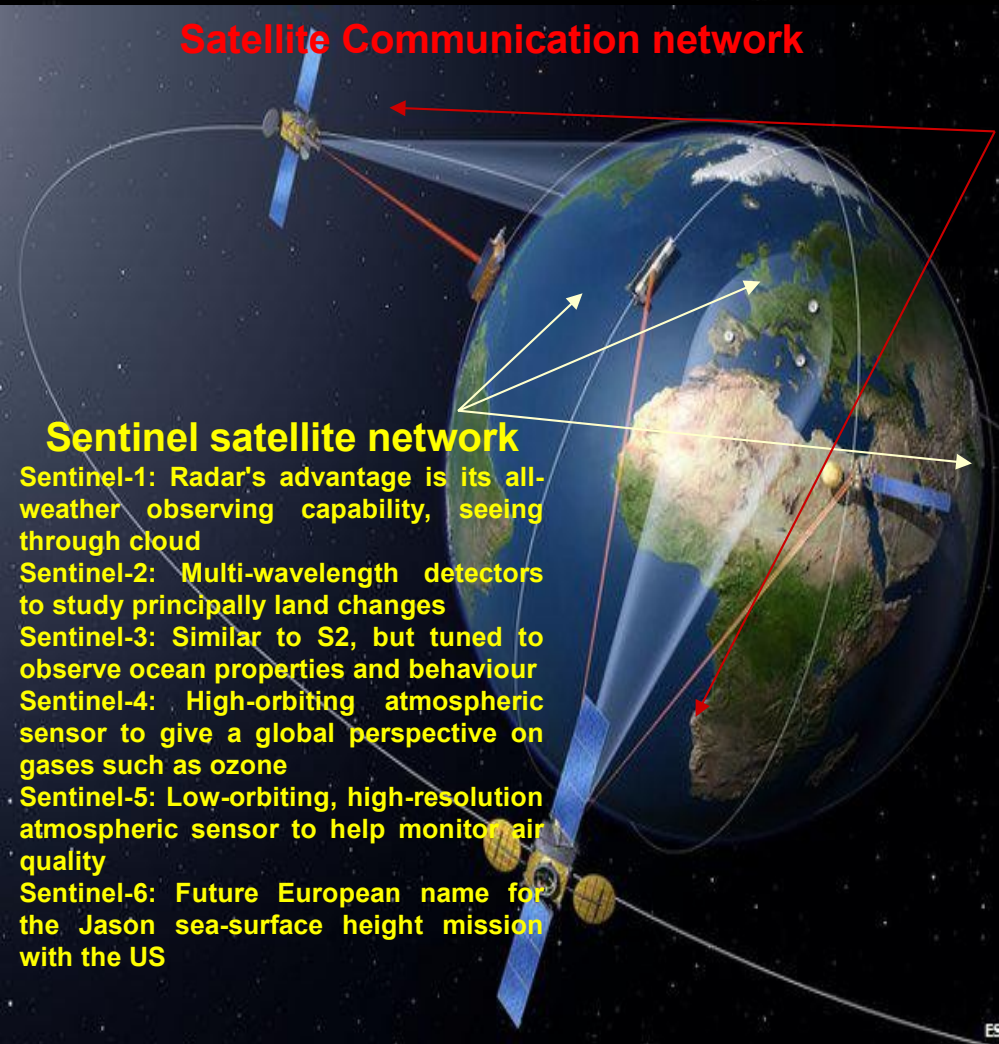
BRIGHTCAP VENTURES €25M entrepreneur-led, globally-supported, venture capital fund with a focus on companies with global potential in software and applied engineering

TEAM	70+ years Europe, USA, Israel Business/Ops Leadership Technology Leadership Investment Banking EXPERIENCE	Entrepreneurs Sciant, ADX, Aviaso, Auxionize, FranceBusinessPlus, OPTIIM TRACK RECORD	Corporate & Investment VMware, Honeywell, HP, Mercury, Citigroup, Wit Soundview BREADTH	Top Schools Stanford Tel Aviv University University of World Economy Sofia Medical University ALUMNI
	Bulgaria & SEE + Silicon Valley, Israel Invest in SEE tech start-ups Import growth-stage startups REGIONAL	Early-Stage VC + Accelerator Initial acceleration for extended due diligence Series A capital support STAGED	Strategic & Corporate Partner with leaders in core domains to identify and validate market disruptors SUPPORTED	Nurture Help portfolio companies with recruitment, global customer traction, and fundraising from US/IL VC's through local partners GLOBAL

A 25M Euro Bulgarian Investment Fund (accelerator and early stage): partners are WELCOME !

EU's Earth Observation *COPERNICUS* and Global Positioning *GALILEO* Programs – drivers for space entrepreneurship

Satellite Communication network



Sentinel satellite network

Sentinel-1: Radar's advantage is its all-weather observing capability, seeing through cloud

Sentinel-2: Multi-wavelength detectors to study principally land changes

Sentinel-3: Similar to S2, but tuned to observe ocean properties and behaviour

Sentinel-4: High-orbiting atmospheric sensor to give a global perspective on gases such as ozone

Sentinel-5: Low-orbiting, high-resolution atmospheric sensor to help monitor air quality

Sentinel-6: Future European name for the Jason sea-surface height mission with the US

ESA

Copernicus
accelerator

Apply before 15 September to participate in the 2018 Accelerator

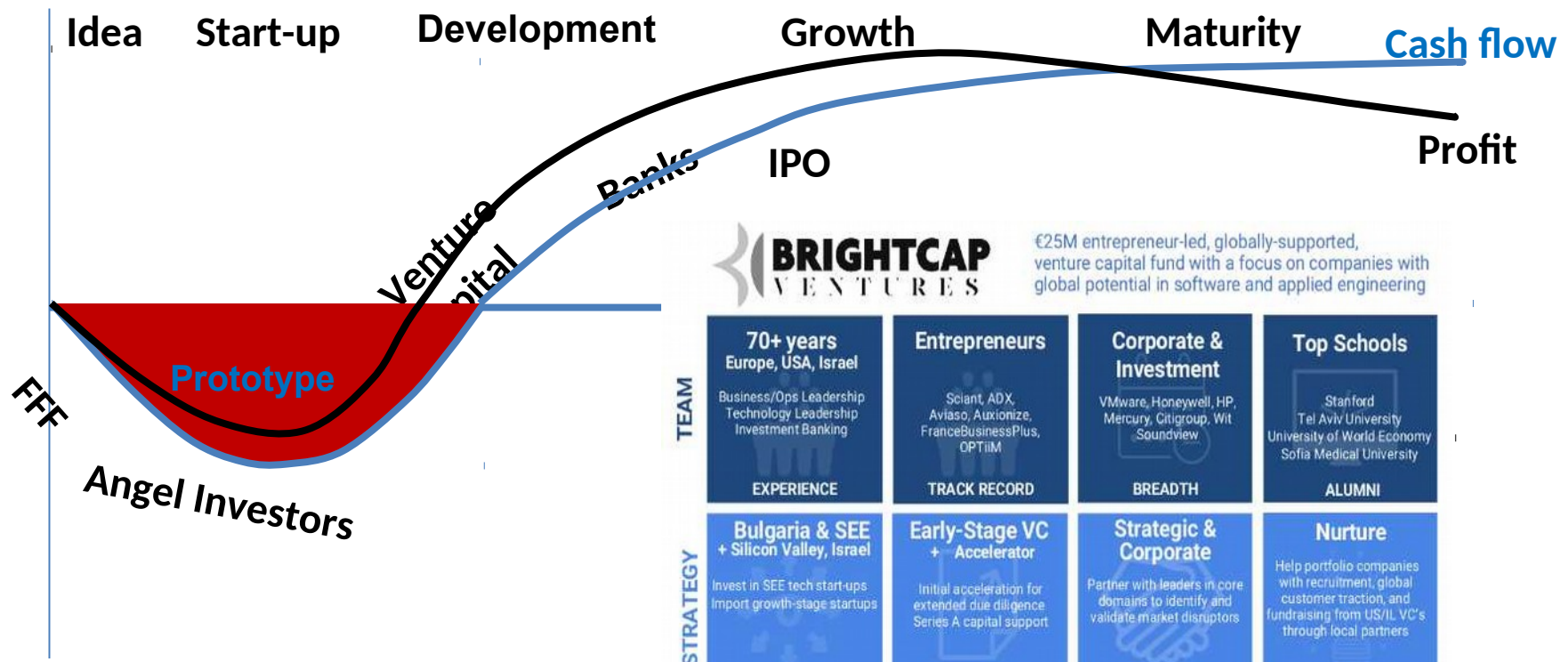
SIGN UP NOW

The Copernicus Accelerator offers a customised business development scheme for 50 visionary start-ups and entrepreneurs from Copernicus Participating Countries (EU, Norway and Iceland) per year. These 50 candidates all have in common that they develop innovative ideas which are tackling societal challenges by using Earth observation (EO) data, especially from Copernicus.

Since 2016, the programme supports the Accelerator candidates to move beyond idea conception into real world implementation. Selected participants are matched with high-level professionals and benefit from a network of experts and mentors. For more information, visit www.copernicus-accelerator.eu or call 0200-100-17-242.dial-up.telesp.net.br

The Role of Investment Funding for boosting space startups

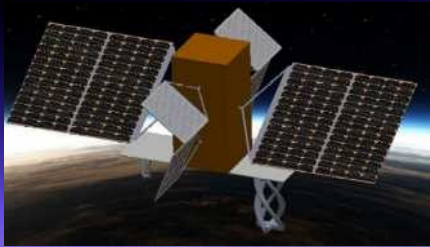
Investment v. Business Life Cycle



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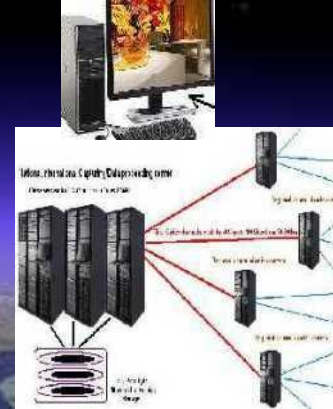
CASTRAs approach to space: Integration and operation of small satellite based ICT systems for specific business cases



Microsatellite



Ground data station(s) and control room; (stationary and/or mobile)



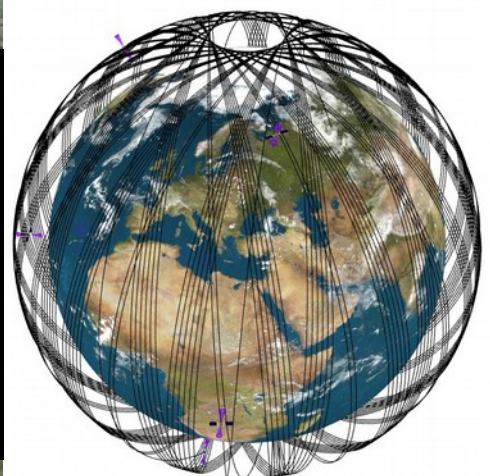
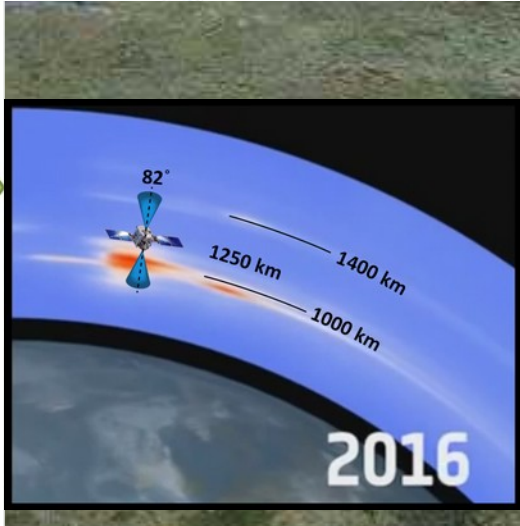
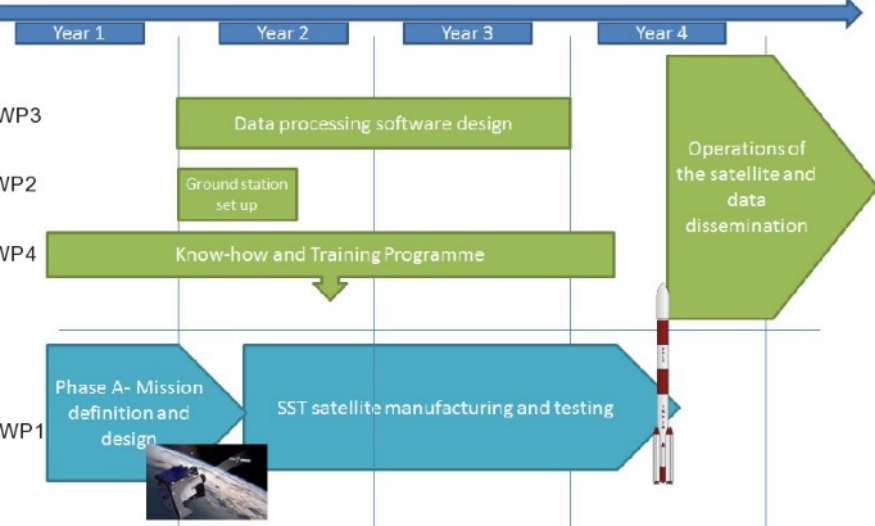
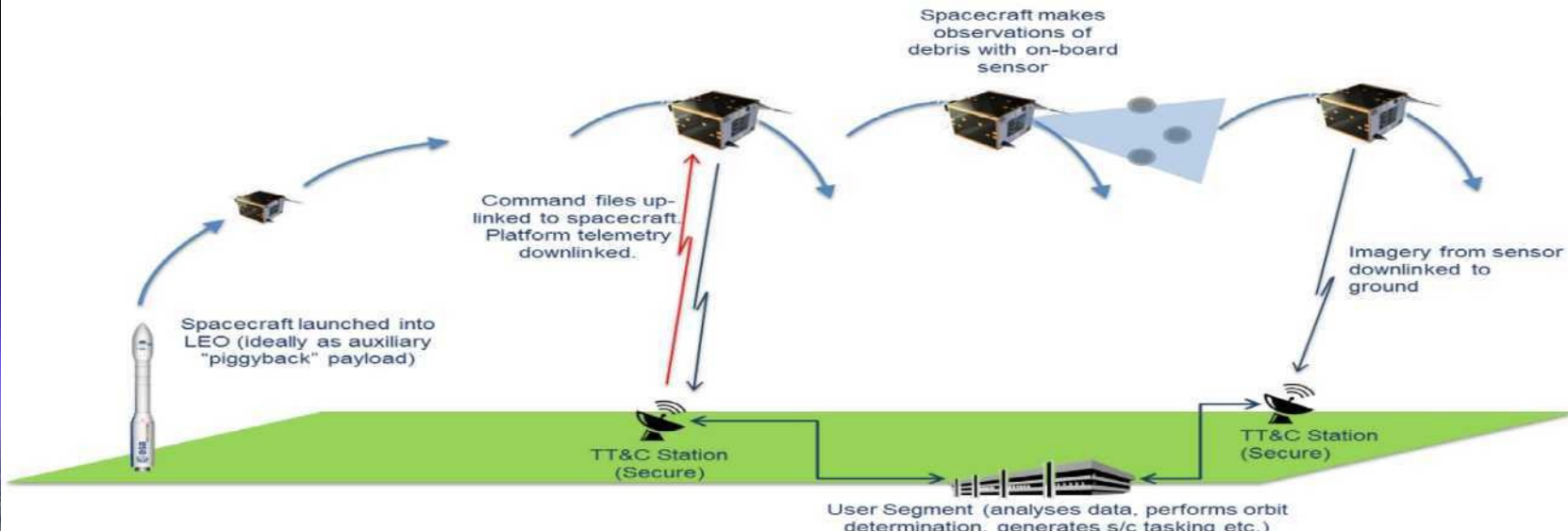
ICT infrastructure for data analysis, processing, archiving and dissemination



Qualified and motivated team of trained specialists

The development and integration of functional space ICT systems requires close cooperation and joint efforts

BULGARIAN SPACE BUSINESS SME INITIATIVES - A Satellite Based Space Debris Surveillance ICT system



OUR APPROACH TO COOPERATION

- ✓ IDENTIFY MATCHING / COMPLIMENTARY BUSINESS VALUE CHAINS OF INTEREST
- ✓ ESTABLISH JOINT R&D AND B2B INTERACTION BASED ON THE CAPACITY AND EXPERTISE OF THE PARTNERS
- ✓ DEVELOP JOINT B2B AND B2C PROJECTS IN THE TECH VALUE CHAIN
- ✓ DEFINE AND IMPLEMENT A JOINT PRODUCT/SERVICE

“Together we are stronger” - Bulgarians strategy to success

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Bulgarian Students Space Debris Removal Project

developed under the UNISEC - driven

Mission Idea Contest

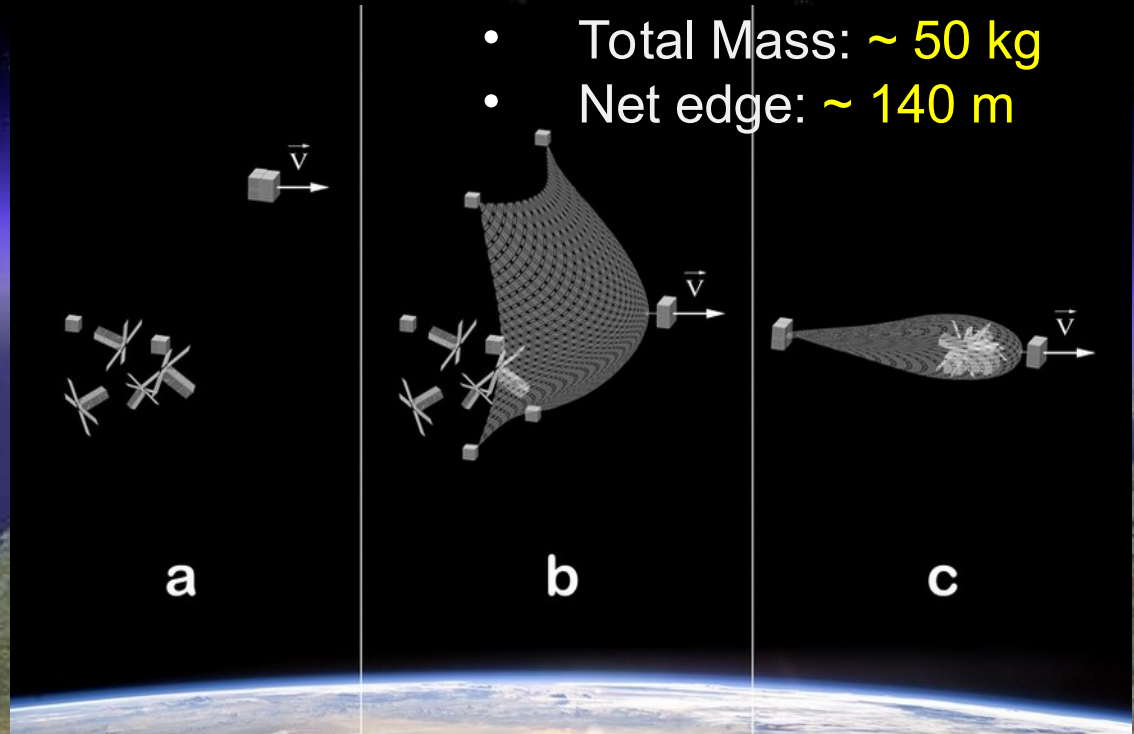
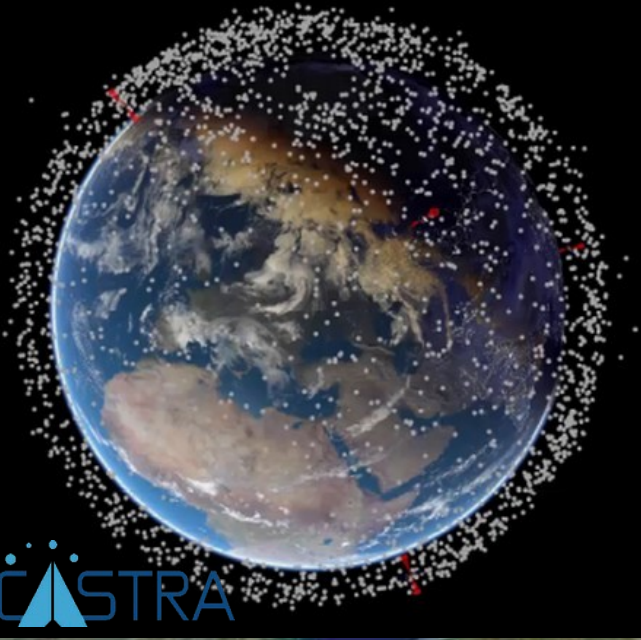
www.spacemic.net



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

Bulgarian Students Space Debris Removal Project

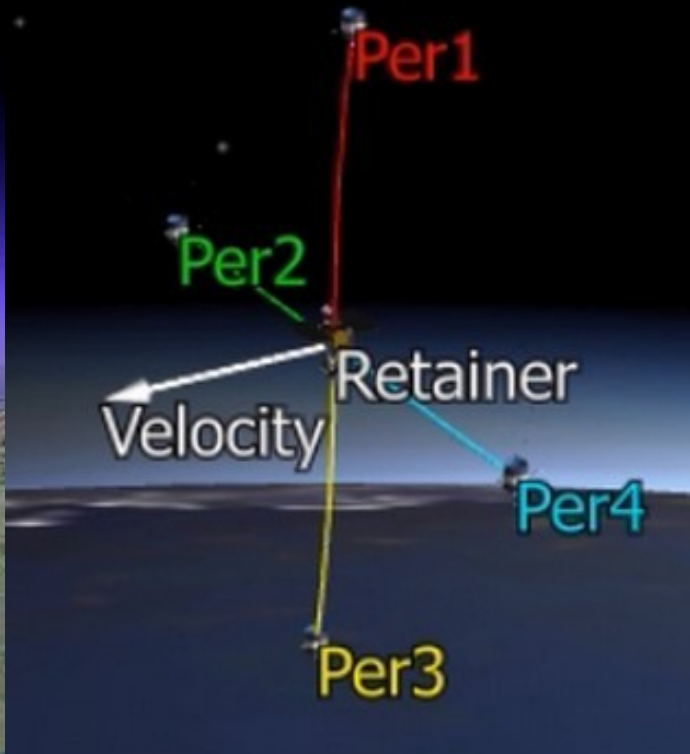
- 5 autonomous units
- Total Mass: ~ 50 kg
- Net edge: ~ 140 m



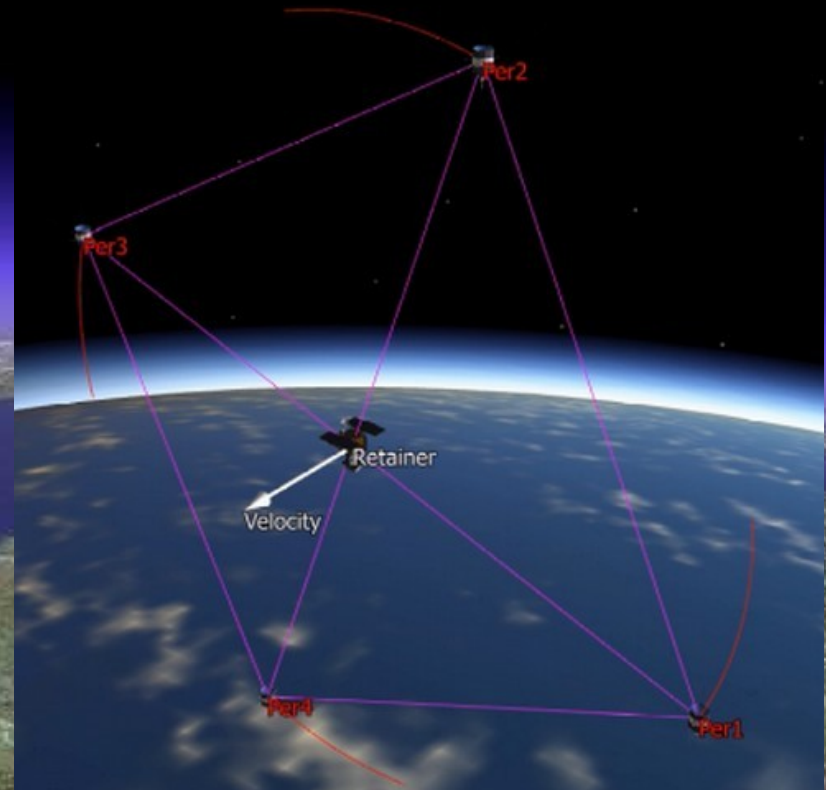
The PROBLEM:
Space Debris number
increase dramatically

A SOLUTION:
Space Debris removal mission
using novel small cubesat
formation mission

Flight Profile Optimisation is needed: Modeling and Simulation



Bottom satellite is faster, top satellite is slower, Left and Right satellites oscillate around the trajectory of the central cubesat



Optimized flight profile of the cubesat formation by introducing rotation [S.Ivanov et al, 2017]

A journey of a thousand miles begins with a single step

千里之行，始於足下

(qiānlǐ zhī xíng, shǐ yú zúxià)

Laozi



LET US DO IT TOGETHER