Клъстер АЕРО-КОСМИЧЕСКИ ТЕХНОЛОГИИ, ИЗСЛЕДВАНИЯ И ПРИЛОЖЕНИЯ

Cluster AERO-SPACE TECHNOLOGIES, RESEARCH AND APPLICATIONS

Consolidating Bulgaria's capacity in the space technology R&D and industry applications sector

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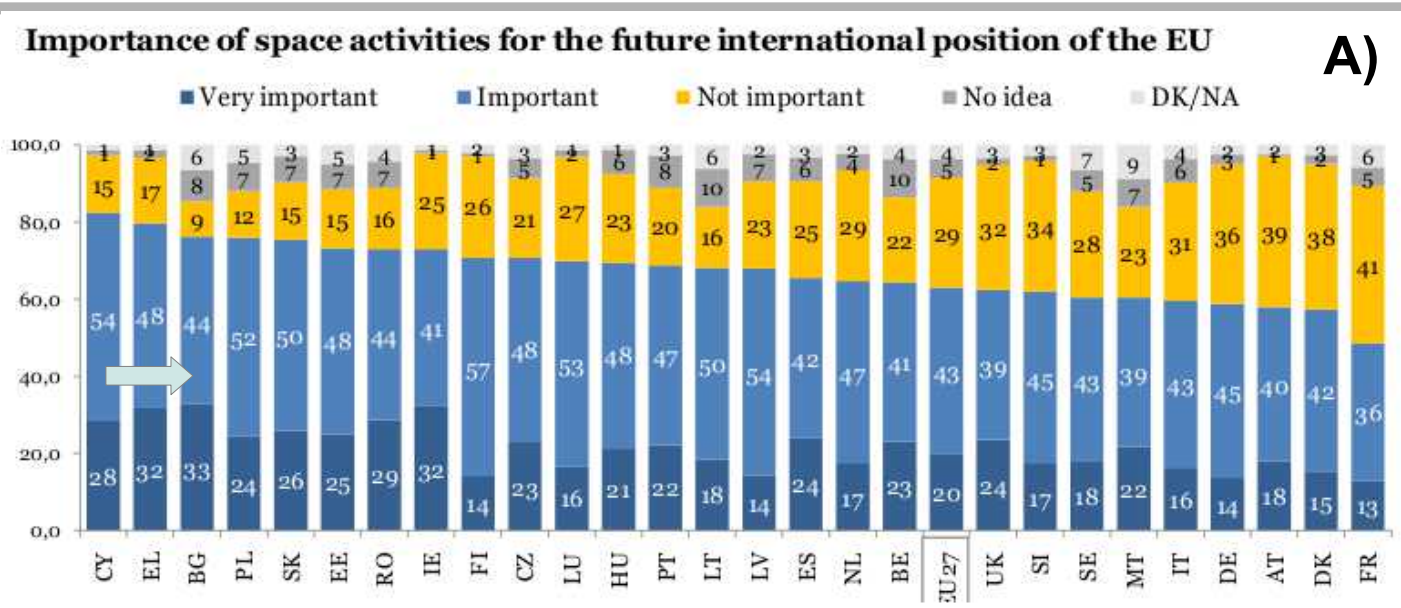
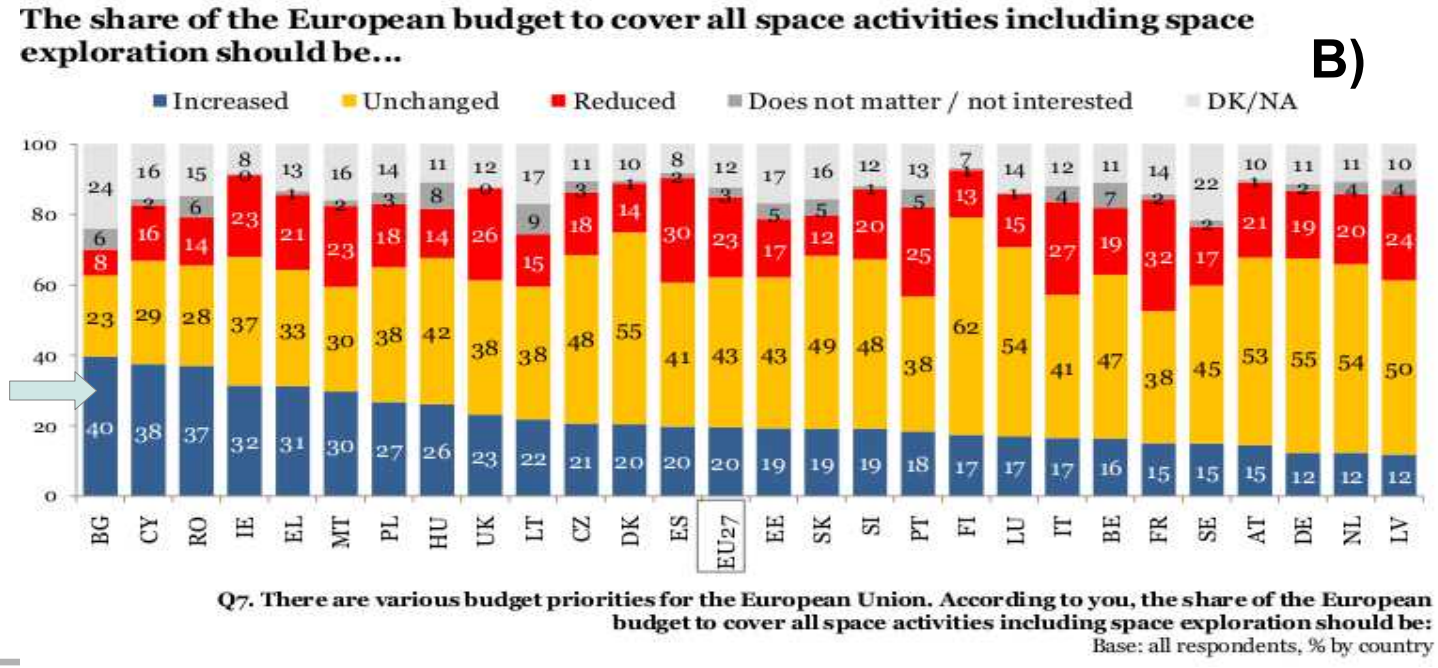
Motivation #3 : People just WANT IT!



The public opinion in the East European countries is strongly biased towards supporting the importance of space programs for the EU future *(see chart A)*.

Bulgarians Public Support for Space



The public opinion in Bulgaria supports the most the increase of the EU budget for space programs
(*see chart B*)

EU survey analyses
('Eurobarometer', 2012)

Bulgarian space activities and EU

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

Bulgaria's space matters coordination mechanism

Main EU space Regulations adopted in 2012-2014

1. Regulation (EU) 377/2014 of the European Parliament and of the Council on establishing the COPERNICUS program and repealing the Regulation (EU) 911/2010;

2. Regulation of the European Parliament and of the Council on implementation ans exploitation of the European satellite navigation systems GALILEO

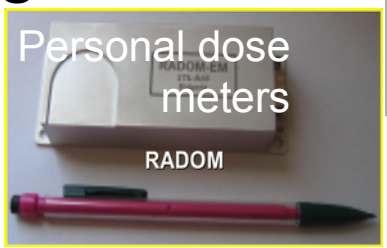
3. Regulation (EU) 1285/2013 of the European Parliament and of the Council on amending Regulation (EU) 912/2010 setting up the European GNSS Agency

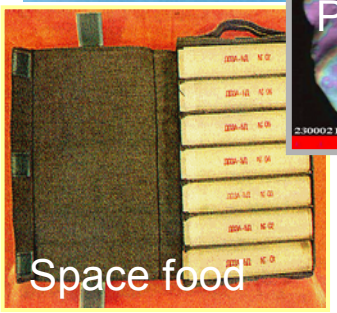
4. Decision of the EP on establishing the Space Surveillance and Tracking Program

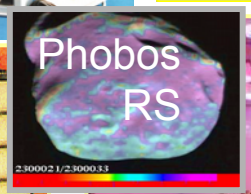
Motivation #2 : Bulgaria's existing potential

TWO Bulgarian cosmonaut space flight programs realized – 1979,1988

Developed unique experience and infrastructure in program management, numerous space born and ground instrumentation development, fundamental sciences and other related areas







NEW high-tech SME potential

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

Who we are?

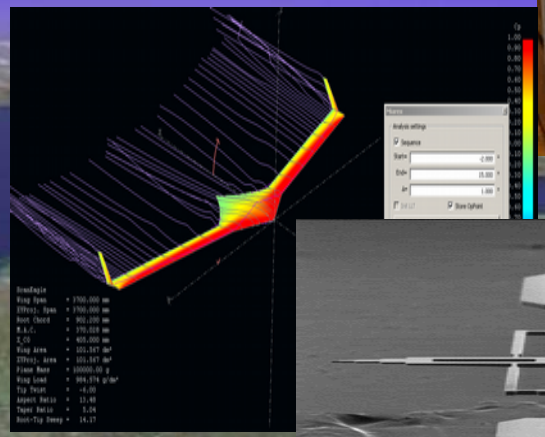
Cluster AERO-SPACE TECHNOLOGIES, RESEARCH AND APPLICATIONS (CASTRA) is a non-government organization in public benefit whose members represent business organizations, academic institutions and non-government organizations with activities and capacity to develop aero-space technologies and their application in innovative products and services.

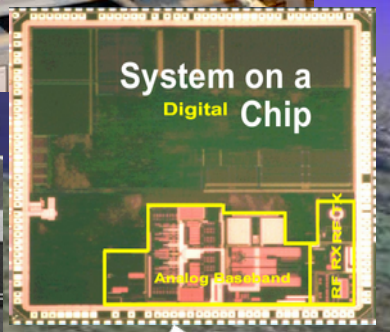
CASTRA's *vision* is to promote the research, innovation and technology development in the aero-space domain,the applications in industry and in all spheres of public activities and private life.

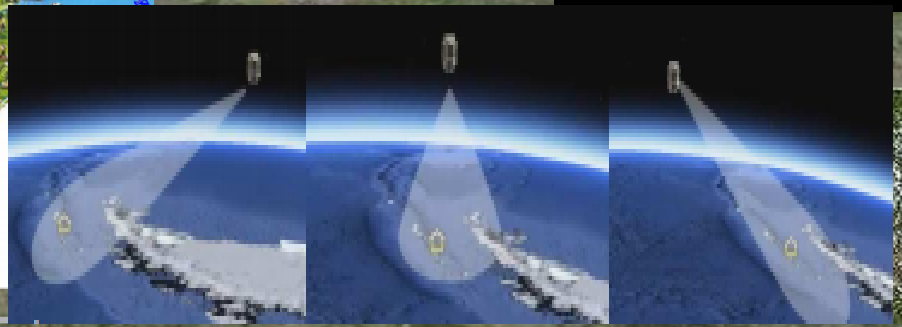
CASTRA's *mission* is to stimulate the public interest and positive disposition to the field of aero-space technologies and research, to increase the public awareness about the importance of space technology applications and spin-offs in various areas of life on Earth and to the activities of the organizations - members of the cluster.

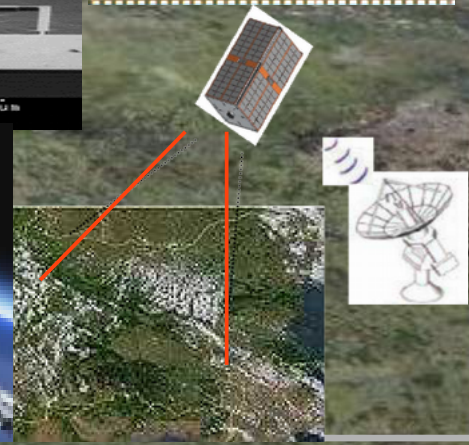
SMEs' and Industry- Clustering Approach

Industrial cluster with members such as SME's, business organizations, academic institutions and non-government organizations with activities and capacity to develop aero-space technologies and thei application in innovative products and services.



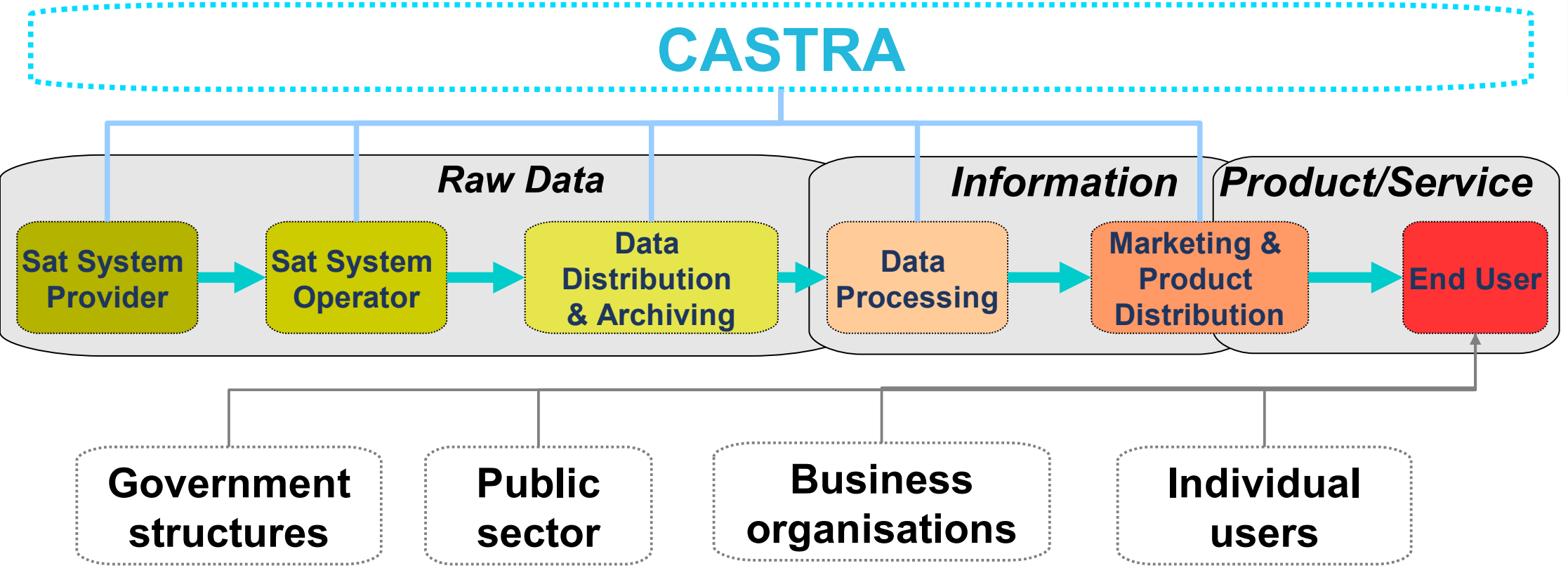






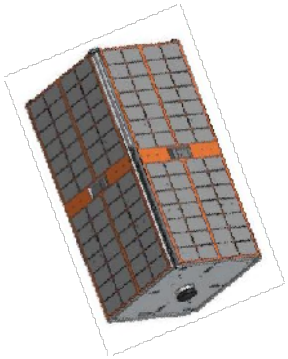
CASTRA's Approach

- ✔ Develop R&D and business interactions in the sector
- ✔ Consolidate the capacity and expertise of the players
- ✔ Develop projects in the whole space tech value chain
- ✔ ***DEFINE and IMPLEMENT a DRIVER PRODUCT***



Typical value chain of a space based ICT system

A satellite based ICT system



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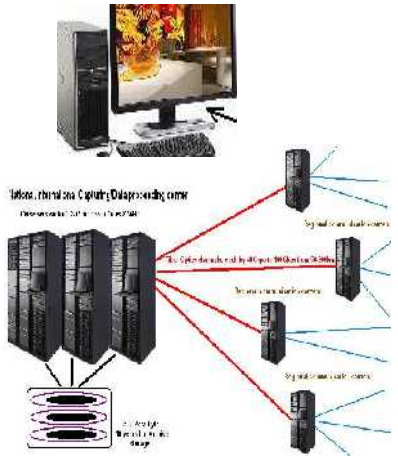

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Minisatelite <1000 kg

➢ ***Microsatelite*** **<100 kg**

Nanosatelite <10 kg

Picosatelite <1kg

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

Information and communication (IC) infrastructure for analysis, processing, archiving and dissemination of data

Qualified and motivated team of trained specialists

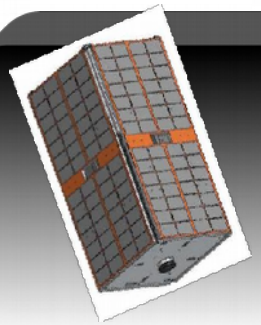
The development and integration of all components requires close cooperation and joint efforts of organizations with complementary expertise and creation of space technology eco-system

Small Satelitte Applications

Natural Disaster Monitoring, Emergency Response, Security

Monitoring of Water Resources

Ecology, Agriculture, Natural Resources



Satelitte based ICT

Tellecommunication (data transfer and buffering, position tracking,etc..)

Games, Fun, Advertising ...

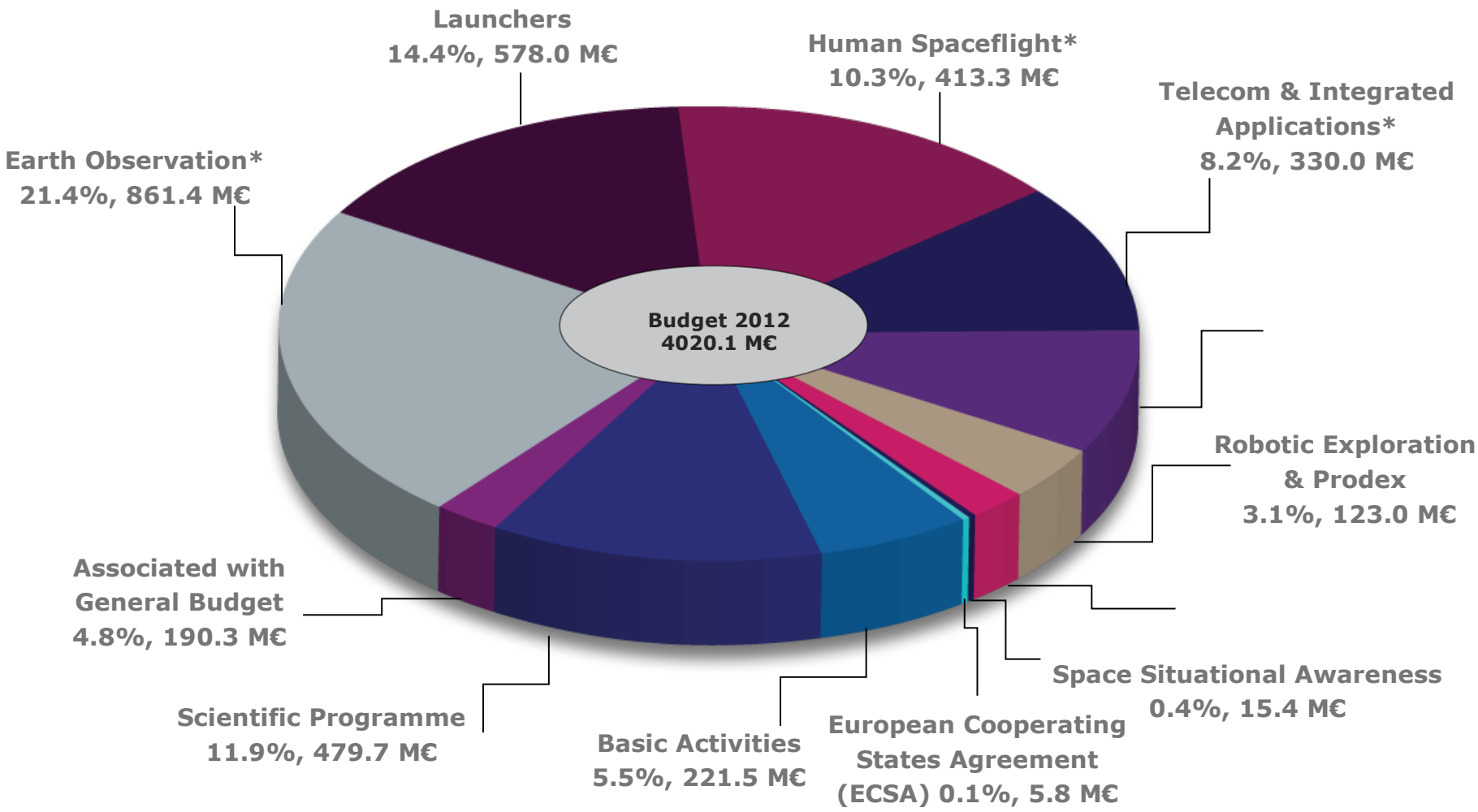
All the rest ... :-)

Motivation #1 : strong industry potential

Typical yearly budget of the European Space Agency

M€: Million Euro

***includes Third Party Activities**



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

Small Satellites are of interest to NATO, EU.

UNCLASSIFIED / UNLIMITED

Technical Activity Proposal (TAP)

Activity reference number	AVT-210	Activity Title	Approval 2012
Type and serial number	RWS-015	Risk and Reliability Assessment and Validation for Small Spacecraft	Start March 2012
Location(s) and Dates		In conjunction with the AVT Spring 2013 PBW, Sweden, May 2013	End December 2013
Coordination with other bodies		SAS, SCI, SEI	
NATO Classification of activity		NU	Non NATO Invited Yes
Publication Data		MP	NU
Keywords		Small Satellites, Reliability, Risk Assessment, Low cost spacecraft, Validation and verification, Assembly Integration and Test	

I. Background and Justification (Relevance to NATO):

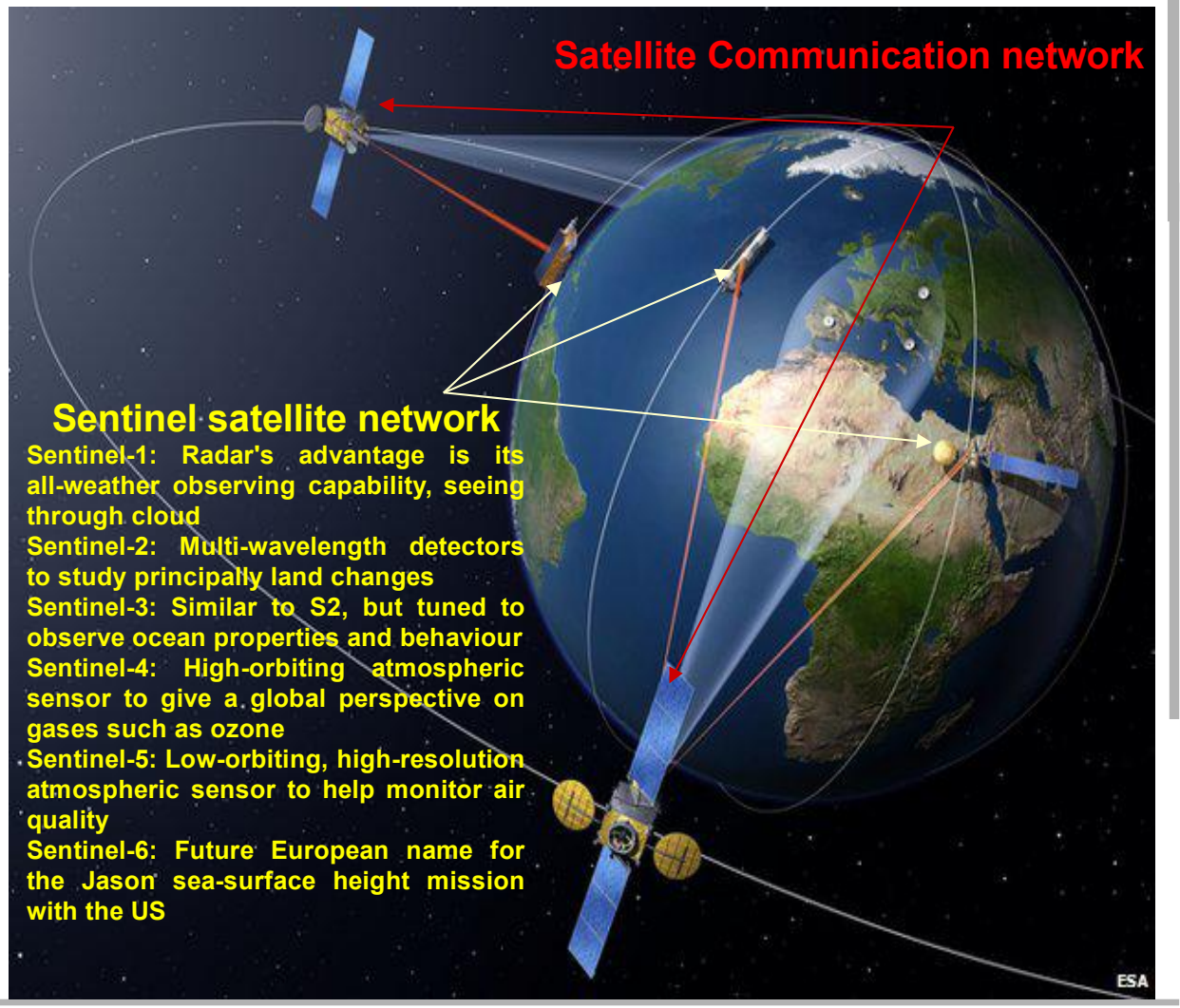
Homeland and global security, out-of-area peace-keeping missions with rapid reaction forces, and asymmetric warfare constitute new conditions for armament. To meet these needs, extended ISR (Intelligence, Surveillance, and Reconnaissance) will be a prerequisite. The upcoming new generation of small satellites and space vehicles offer a new ISR potential that benefits the future war-fighter. The primary features of small satellites are that they are significantly cheaper than larger platforms and that they can be launched with low cost, rapid response launch systems. Moreover, small satellite technology is enabling for the deployment of constellations or formations of space assets that can perform military surveillance tasks with increased resolution, repeat cycle and performance.

The development of small satellites is linked to a number of low mass and high performance technologies ranging from propulsion, to materials for structural and thermal control, to the miniaturization of sensors and actuators, to the realization of miniaturized electronics for multipurpose distributed tasks, and to the usage of advanced power generation systems. These must be combined into one spacecraft to provide a reliable, efficient and affordable system. Specifically, the advantage that is seen for small satellites is the ability to develop low cost, responsive systems to meet a range of needs and missions in both complexity and duration. These may be long term missions that a constellation of small satellites can provide such as increased coverage or increased revisit capability for remote sensing or information gathering; or rapid response to immediate needs due to an insurgent situation or a loss of other assets. In either case, the goal to provide a cost effective system must be measured in terms of risk and reliability in relation to the mission objective. Only through a proper assessment and evaluation of risk, reliability and projected performance can savings in cost (in terms of dollars and time) be achieved. New techniques and approaches must be developed to realize these savings.

The recent AVT Workshop on Multifunctional Structures and Systems Technologies for Small Spacecraft identified a number of important technologies that must be developed to realize the full capability and value of the use of small satellites. However, the primary technology identified in order to meet mission objectives and performance at optimum cost was verification of the system in light of the mission defined risks and required reliability. Standard spacecraft verification approaches and techniques as defined in MIL-Std-1540 for current (and large) spacecraft impose a heavy burden on verification through test and analysis. Although these techniques have been generated and verified through space hardware experience for major spacecraft with long durations and associated large budgets, the cost imposed on small spacecraft whose mission may be short can sometimes overburden the available budget of time and money. A fresh approach is needed to ensure that the spacecraft developed is consistent with the mission requirements for which it was intended. As an example, although not exactly the same, this situation is closely paralleled by the new approaches being investigated for UAVs as compared to manned aircraft in order to ensure that the vehicle reliability is optimally matched to the planned mission requirements.

One of the major goals of the RTO is monitoring emerging technologies and bringing together experts to present and discuss the needs and ideas for these new technologies for application in their fields. The ET-110 has identified the need for new approaches and techniques for validation in order to more completely access the benefits of small sats and identified a proposed plan to identify the elements of these new approaches through a follow-on Technical Team as described below.

EU COPERNICUS Program for Earth Observation



Classification of the main types of information obtained using satellite data

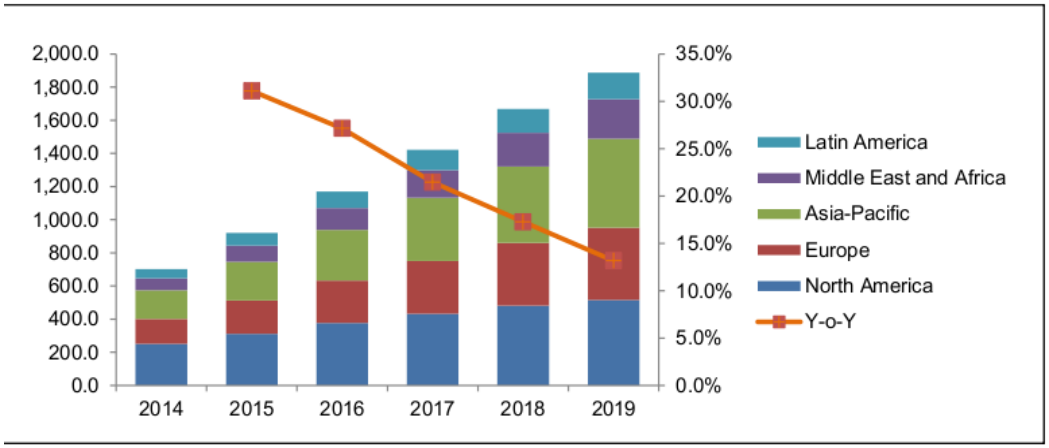
Atmosphere	Cloud properties, including amount, optical properties, and height Radiative fluxes at the top of the atmosphere and the surface Precipitation Tropospheric chemistry, including ozone and precursor gases Stratospheric chemistry, including ozone, BrO, OH, and trace gases Aerosol properties in both the troposphere and stratosphere Atmospheric temperature Atmospheric humidity Lightning, including events, area, and flash structure	**(източник NASA)**
Solar Radiation	Total solar irradiance Ultraviolet spectral irradiance	
Land	Land cover and land use change Vegetation dynamics Surface temperature Fire occurrence, including extent and thermal anomalies Volcanic effects, including frequency of events, thermal anomalies, and impact Surface wetness	
Ocean	Surface temperature Phytoplankton and dissolved organic matter Surface wind fields Ocean surface topography, including height, waves, and sea level	
Cryosphere	Land ice, including ice sheet topography, ice sheet volume change, and glacier extent Sea ice, including extent, concentration, motion, and temperature Snow cover, including extent and water equivalence	

Market Survey (full report in a separate document)

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

Region	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
NA	250.4	311.8	376.1	432.9	480.5	515.7	15.5%
EU	150.6	199.9	257.7	317.9	379.0	436.0	23.7%
APAC	173.4	233.4	305.1	381.3	460.7	537.2	25.4%
MEA	72.2	99.1	131.7	167.0	204.1	238.0	26.9%
LA	55.8	76.6	100.1	122.8	143.1	160.3	23.5%
Total	702.4	920.8	1170.7	1421.9	1667.4	1887.1	21.8%

NANO AND MICROSATELLITE MARKET SIZE, BY REGIONS, 2014-2019 ($MILLION, Y-O-Y (%))



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%

CASTRA's *2nd-ary* target markets

CASTRA's MAIN target markets

COMMUNICATION, NANO AND MICROSATELLITE MARKET SIZE, BY REGIONS, 2014-2019 ($MILLION)

Region	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
NA	36.6	44.0	50.6	54.6	56.1	57.8	9.6%
EU	21.3	27.7	34.4	40.1	44.6	48.1	17.7%
APAC	26.2	33.9	42.0	48.9	54.2	58.4	17.4%
MEA	10.3	13.8	17.5	20.9	23.8	25.8	20.1%
LA	5.8	8.3	11.0	13.4	15.1	16.8	23.6%
Total	100.2	127.7	155.5	177.8	193.8	206.8	15.6%

EARTH OBSERVATION AND REMOTE SENSING, NANO AND MICROSATELLITE MARKET SIZE, BY REGIONS, 2014-2019 ($MILLION)

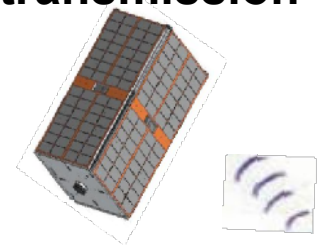
Region	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
NA	29.4	45.2	66.5	91.5	120.8	148.6	38.3%
EU	18.0	30.0	47.7	71.0	101.4	135.9	49.8%
APAC	20.4	34.3	55.4	83.4	120.8	164.1	51.8%
MEA	8.4	14.0	22.6	33.9	48.9	66.1	51.2%
LA	4.9	8.8	14.5	21.7	30.7	41.0	52.8%
Total	81.1	132.3	206.6	301.5	422.7	555.8	47.0%

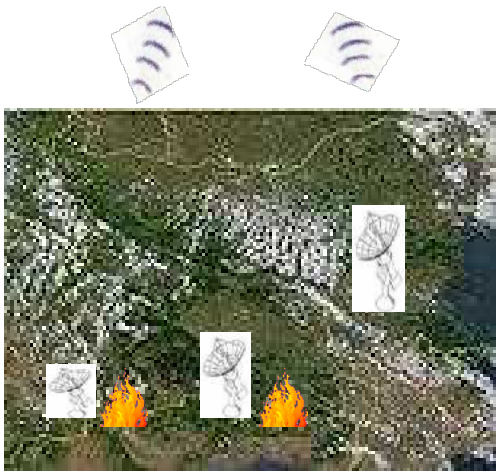
Main business applications of our system

Application №2:

Wireless data transfer from/to on-ground sensor networks OR data users, followed by data exchange with a remote receiving station....

Position 1: **data collection and transmission**

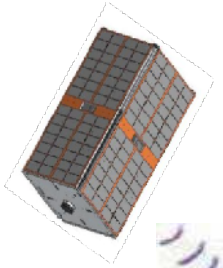


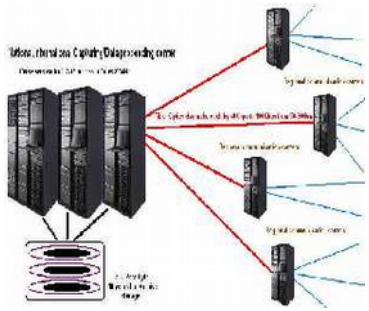


on-ground sensor networks

remote user without communication (e.g. the Bulgarian Antarctic base)

Position 2: **data download/upload at the control station**

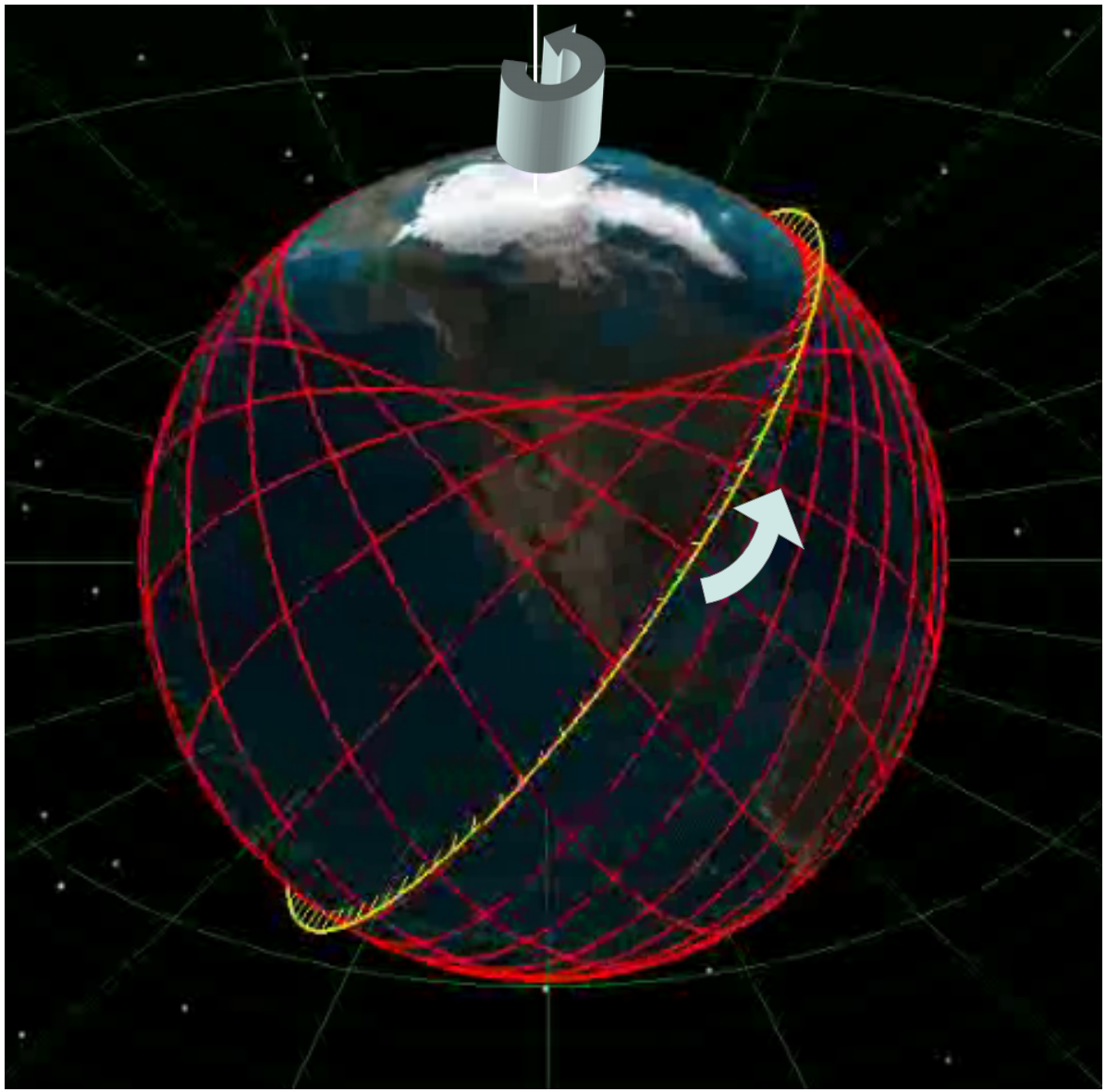




Receiving /control/ station

The simplified orbit analysis shows that our satellite would pass over the Bulgarian base on the Livingston Island ~2 times daily, and over Bulgaria ~1 times per day.

Example: Satellite orbit coverage



Example of a Sattelite Orbiting the Earth

(click the text above to open on-line animation)

The satellite system applications and users define the requirements towards the main orbital parameters such as altitude and inclination, etc.

CONCLUSIONS

- Bulgaria has strong tradition and state of the art expertise and know-how in space exploration – development and implementation of complete scientific and applied research programs; development and deployment of space instrumentation, space fundamental science, ground segment and all related areas.
- Government administration is taking active steps to re-establish efficient national coordination and execution mechanisms for the space and the related R&D and industrial activities within the EU and ESA.
- Various Bulgarian organizations - Academia, Business entities, SME, Industry and NGOs are taking the initiative bottom-up to consolidate the national capacity in space R&D, technology development and transfer, including the related businesses development to the benefit of society

千里之行，始於足下

(qiānlǐ zhī xíng, shǐ yú zúxià)

A journey of a thousand miles begins with a single step

Laozi

