

## CASTRA capacity and current projects in space

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[www.castra.org](http://www.castra.org)

- **General information about CASTRA**
- **Some selected areas of expertise**
- **Small Satellite project for ICT applications**

**Cluster AEROSPACE TECHNOLOGIES, RESEARCH AND APPLICATIONS (CASTRA)** is an industry-driven consortia of business entities, academic institutions and other bodies with expertise and capacity to develop technologies, products and services in the aerospace domain and its applications serving society.

CASTRA has the legal status as a non-for profit organization according Bulgarian law.

**CASTRA's vision** is to promote the research, innovations and technology developments in the aerospace sector to the benefit of society and private life.

**CASTRA's mission** is to stimulate the public interest to the field of aerospace technologies and research and to the activities of the organizations - members of the cluster, to increase the public awareness about the benefits to all life on Earth from developing novel upstream space technologies and their downstream applications.

## Companies

- [Aegis Ltd.](#)
- [Telesys Ltd.](#)
- [Novorell Ltd.](#)
- [Lumycomp Design Ltd.](#)
- [SimSoft Ltd.](#)
- [BEVT JSC](#)
- [BMG Bulgaria JSC](#)
- [PointL-Bulgaria Ltd.](#)
- [MicroPlus Apostolov Ltd.](#)
- [ElectronInvest Group Ltd.](#)
- [KONTRAX JSC](#)
- [O &K SD](#)
- [Mozaika Co -in application](#)
- [Green Embedded Systems](#)

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## Academic organizations

- [Sofia University with its 'Space Research and Technologies Centre“](#)
- [Institute of Cryobiology and Food Technology](#)
- [Technical University of Sofia - Department of Aeronautics](#)
- [Institute for Mathematics and Informatics, Bulgarian Academy of Sciences](#)

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## NGO's

- [Remote Sensing Application Center-ReSAC](#)
- [Bulgarian Modeling and Simulation Association "BULSIM"](#)

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## PARTNERS

Aerospace Engineering and Communications (ASE&C) M.Sc. Program at Sofia University

Bulgarian Institute of Metrology

OPTIX JSC, Bulgaria

Micro-satellite and Space Microsystems Lab, University of Bologna, Italy

\*Cluster of Serbian Aeronautical Industry – UVIS

Bulgarian Air-Traffic Control Authority

Space Mission Control Centre, Russia

Bulgarian Academy of Sciences (BAS) is the biggest R&D organization in Bulgaria. It has 49 R&D institutes in all spheres of science and technology. It has 3570 full time employee researchers and educates 581 PhD students (2010). In 2010 BAS published over 2553 scientific articles at international level



Sofia University is the oldest and the biggest University in Bulgaria.

It educates ~ 23 000 students (2013) in 16 Faculties and it is ranked on 640 position among all Universities worldwide, with strong educational and research activities in the areas of science, law and economics. Together with CASTRA, a new M.Sc. in AeroSpace Engineering and Communications was established in 2012



The Technical University is the most reputable Academic institution active in the field of Engineering Sciences and Technology. It educates ~ 18 000 students (2013) in 14 Faculties. The University has campuses in the cities of Sofia, Plovdiv and Sliven and brings significant expertise in areas such as mechanics, electronics, robotics and other





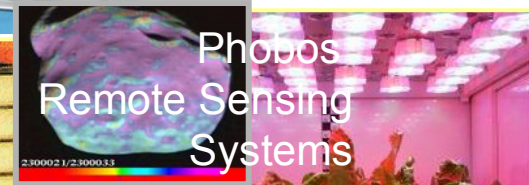
# Some selected areas of expertise

( Additional information available on request )

# Background

## TWO Bulgarian cosmonaut space flight programs were implemented – 1979,1988

Developed unique experience and infrastructure in program management, development of various spaceborn and ground instrumentation, R&D in 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.

LumyComp Design Ltd

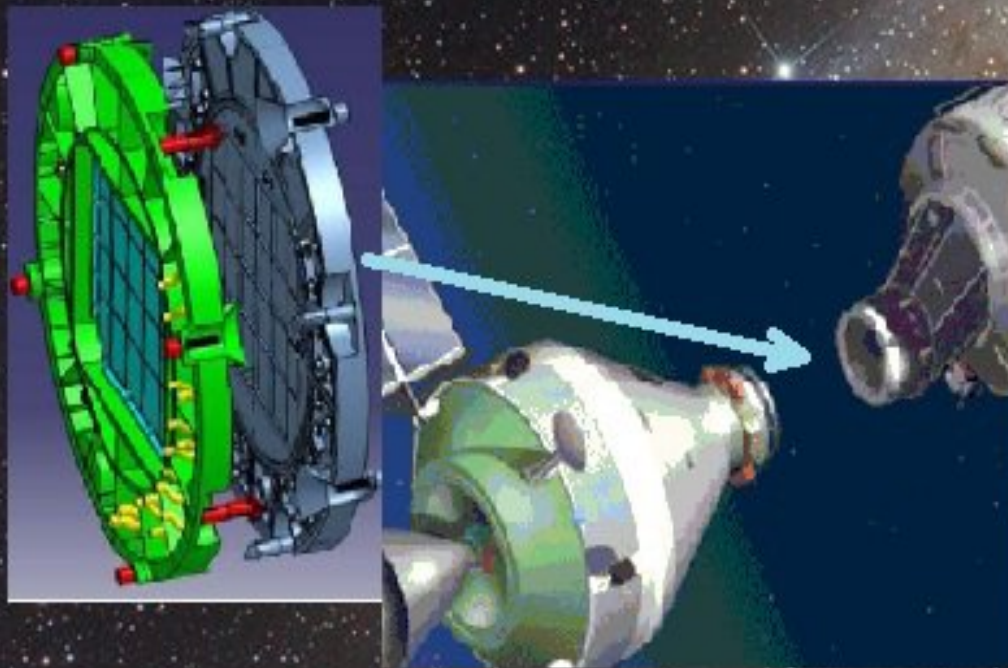




# LumyComp Design

- ESA XMM Newton Telescope,  
mirror PWR control,

1997-1999



- Astrium/ESA proposal for  
Docking Module Standardized  
Multipurpose Androgynous  
Docking Adapter (312294 -  
SMADA) - FP7-SPACE-2012-1

2012

# LumyComp Design

- LED electronics design, more than 60 projects in 10



- H2020, EU funded project – OPTINTEGRAL – advanced displays

OEM electronic design and production – PCB design, production assembly and testing.

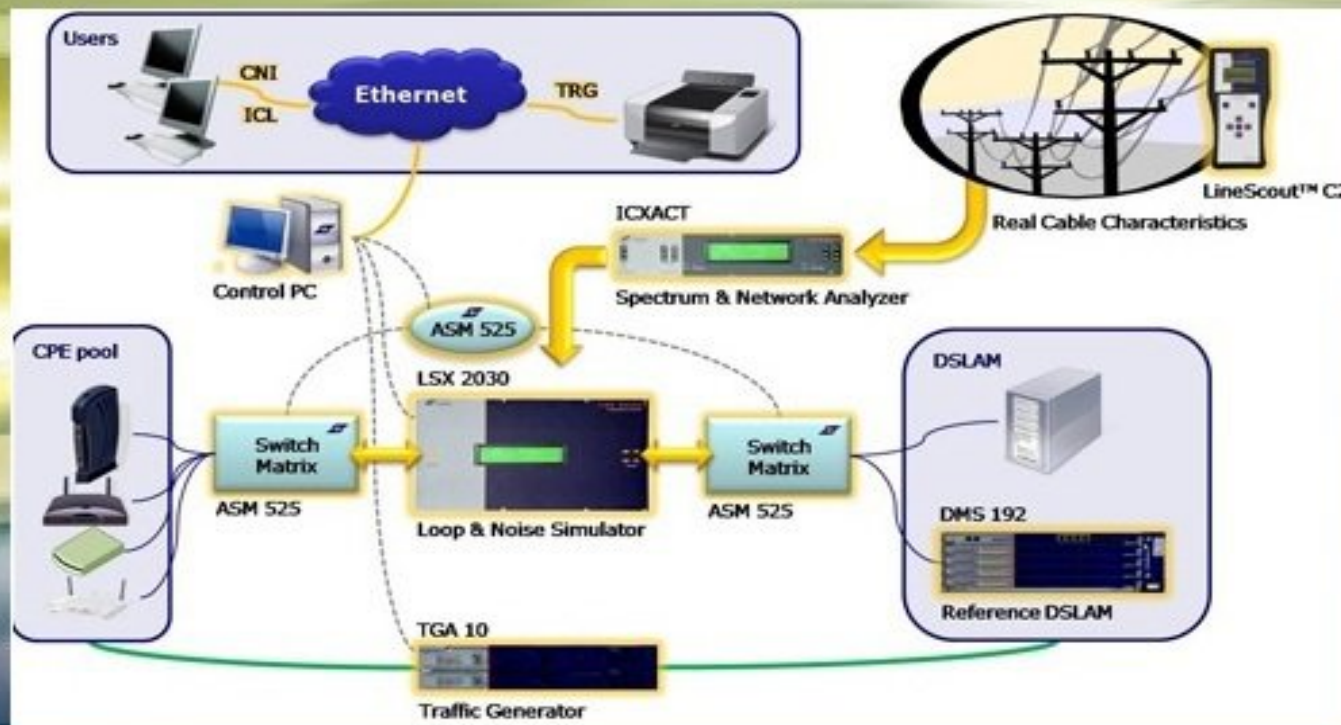


# LumyComp Design

## Telecom measurement equipment :

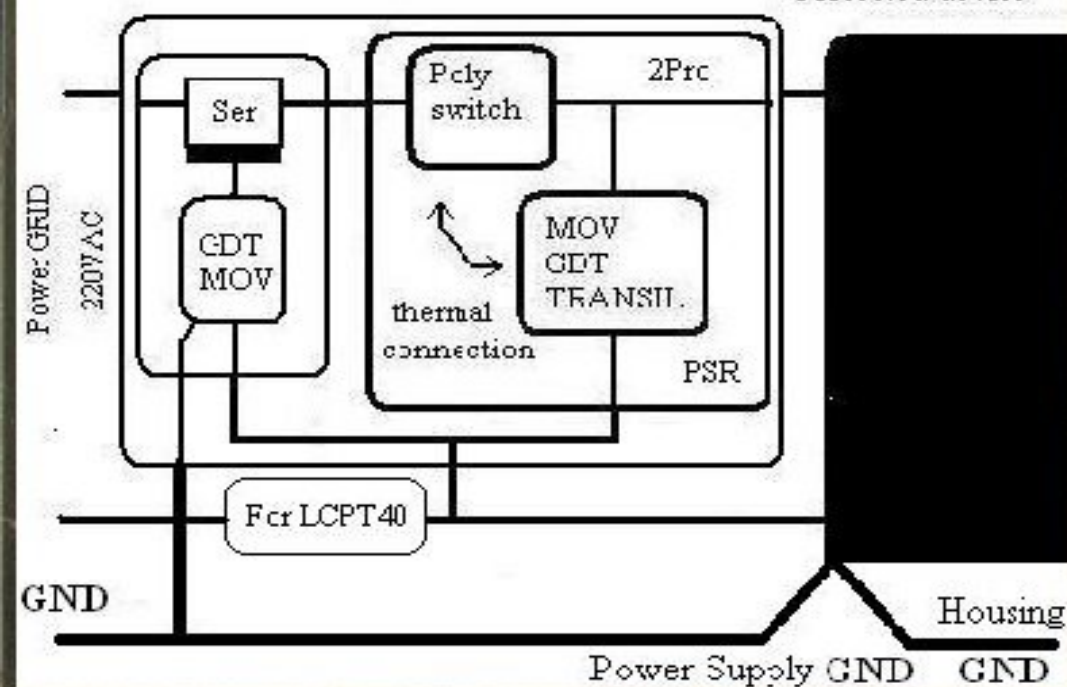
- Low noise (-72 dB signal/noise ratio) Line simulator/tester

- High Tech DSLAM/VDSL2 modem test equipment – 48x1Gbps to 2x10Gbps test structure, Vitesse / Broadcom / Lantiq chipset based.



LCPT 80/160/300

Protected device



## LumyComp Design

- **LCPT (80W, 160W, 300W) – anti-lightning and over-voltage protection – up to 10kV, 10kA / 20usec and up to 415VAC / 1000msec.**
- **Very-High efficient (98%) DC/AC Invertor up to 2kW – participation in the worldwide Google Little Box Chalange 1,000,000 \$ prize competition.**
- **LED drivers and power modules, solar panel and battery management, dimmable modules, DMX / Wireless controlled and thermally protected.**
- **OEM design and production**



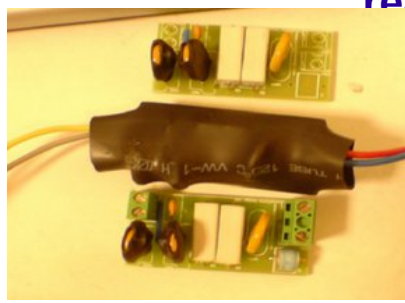


The professional LED devices

# Industrial LED lighting and control systems development for high-reliability and high-spec applications

(e.g. past project underwater LED lighting solutions for the nuclear reactor zone in the nuclear power plant in Kozlodui)

Development of specialised power supply solutions with embedded protection to sensitive electronic modules against over-voltages and currents - e.g. in emergency events (e.g. EMP in phase E1, E3 of a nuclear explosion), protection of military and civil communication and power supply networks against induced overvoltages by solar EM storms (polar regions of Earth, power EM fields near communication antenna and radar equipment, and other

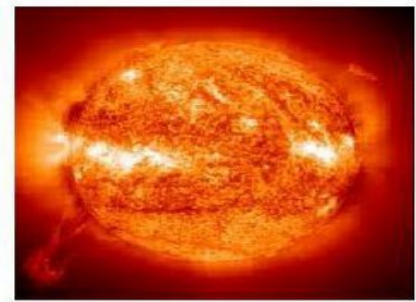


EMP – phase E1 and E3 of Nuclear explosion



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

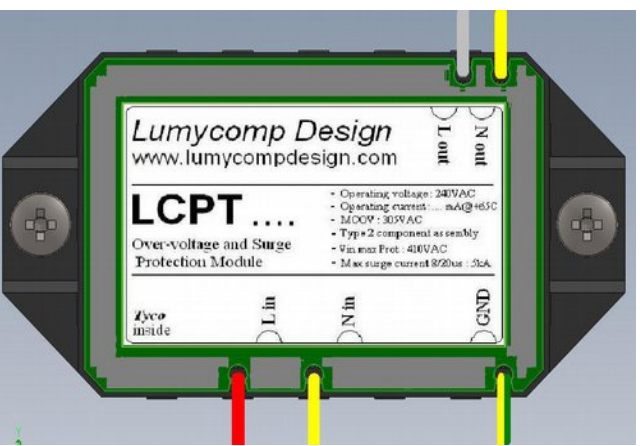
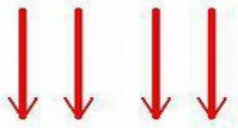
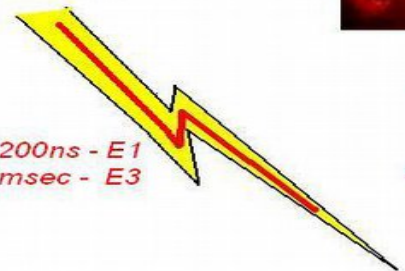
Solar electromagnetic storm



Induced electrical discharges and over-voltages



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



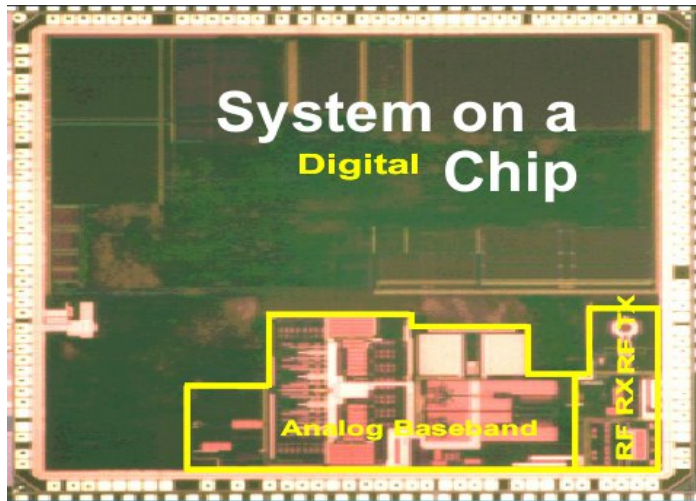
# Novorell Technologies Ltd



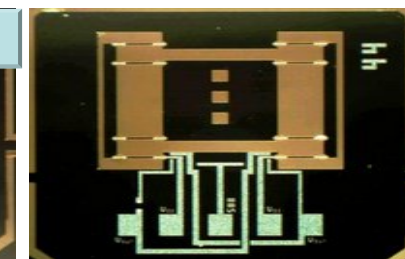
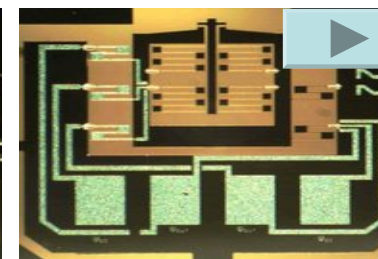
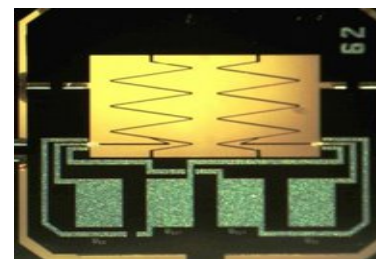
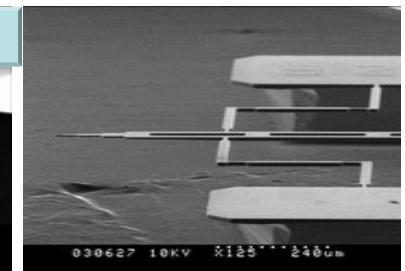
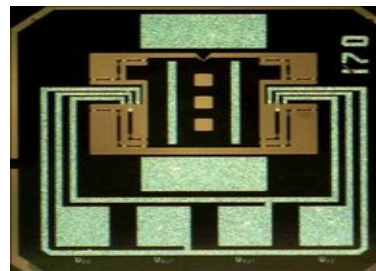
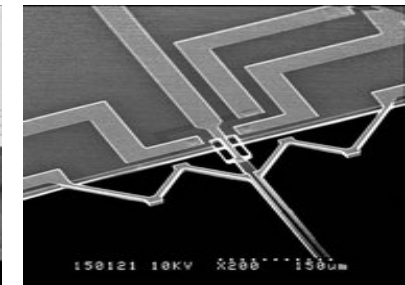
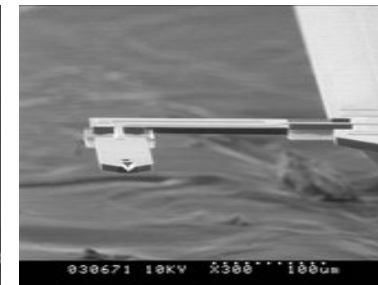
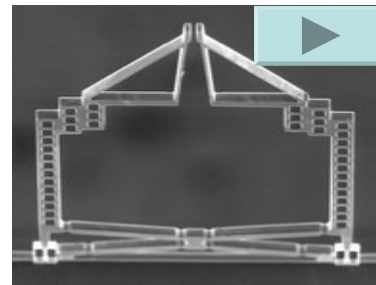


Integrated Circuits design for high-reliability ( e.g, radiation hardness) for space applications (ESA projects)

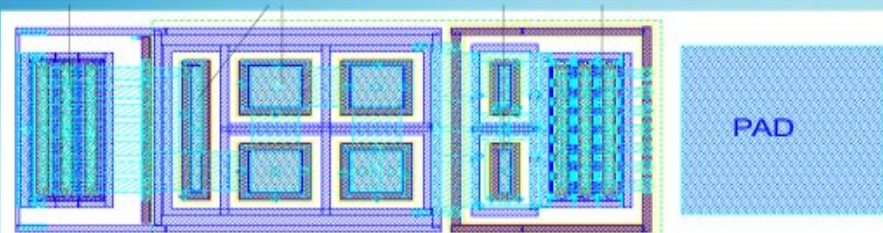
[See seprate presentation](#)



Technology, design and manufacturing of advanced MEMS sensors and actuators for high-precision high sensitivity applications, including avionics, gyro-systems, accelerometers, level meters, force and pressure sensors, gas sensors , bio -sensors



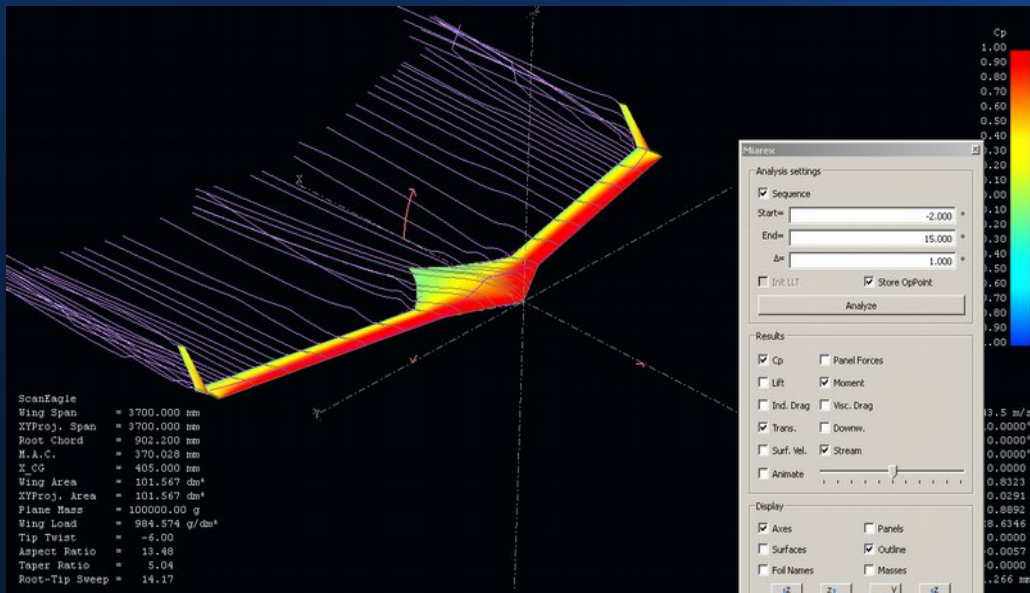
ESD NMOS  $V_{DD\ I/O}$  to  $V_{DD}$  diode string  $V_{SS\ I/O}$  to  $V_{SS}$  diode string ESD NMOS



**Acceco systems**

# O & K CO. Acceco systems capabilities

- Unmanned aircraft systems
- Concept, design, prototyping, production
- High altitude, solar powered aircraft



# O & K co. Acceco systems capabilities

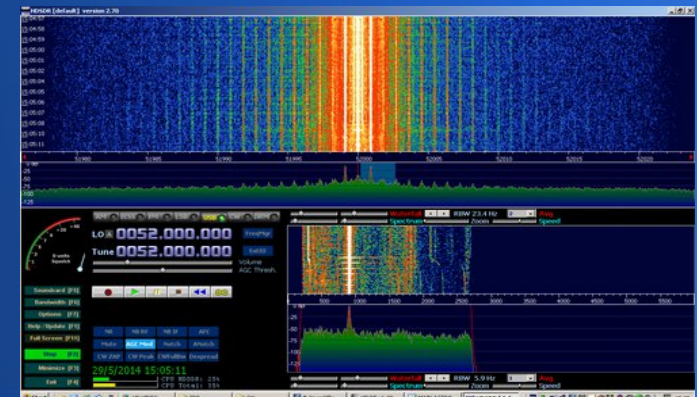
## Sofia University cubesat project

- Microsat prototipe with folding solar panels
- Hi-res imaging/video camera & high speed down/up link /DVB-S2/
- Micro truster /hot gas/ for orbit transfer - safe,low pressure tank

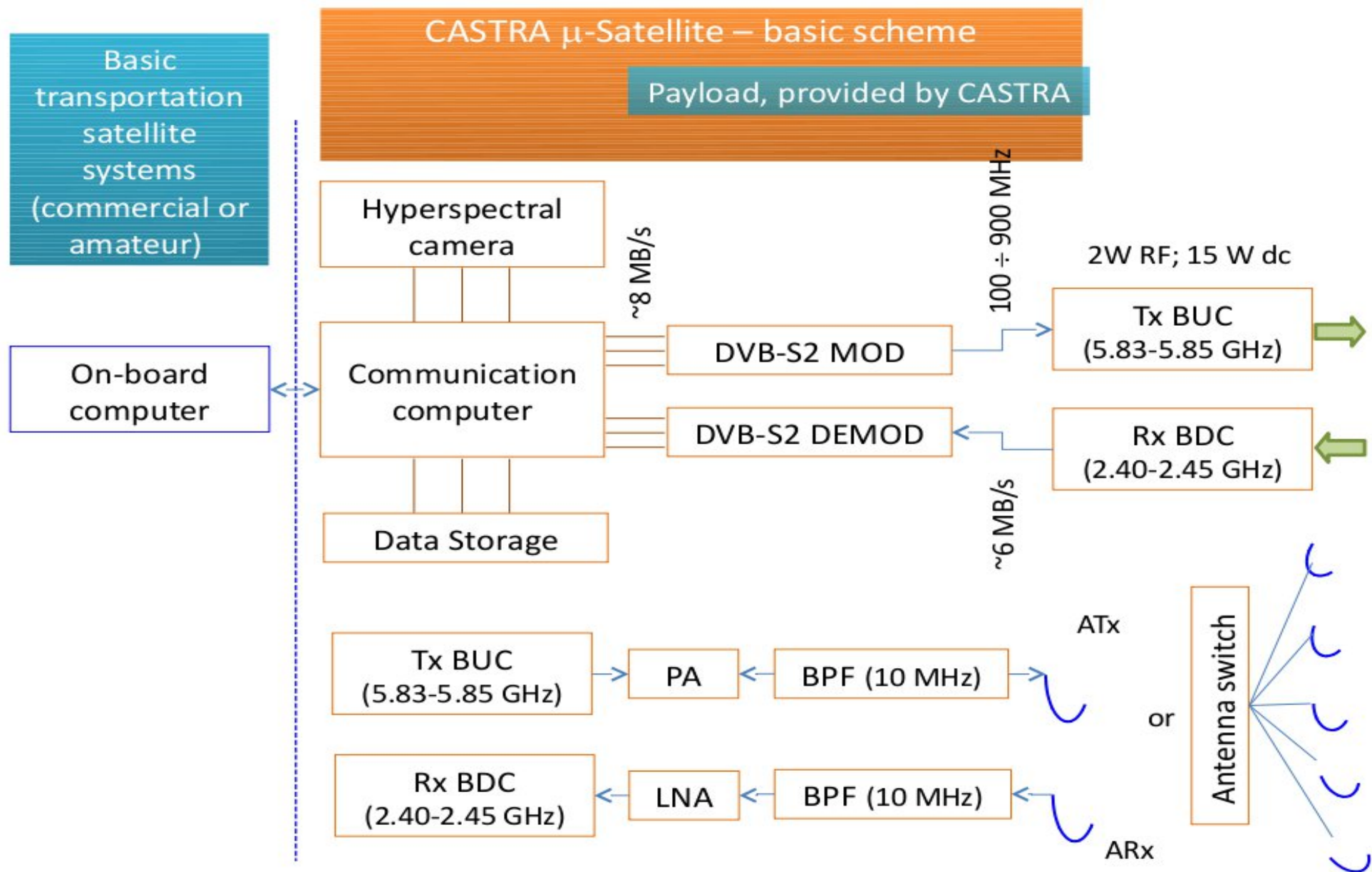


# O & K co. Acceco systems capabilities

- **Communication equipment and laboratory**
- **Sattelite tracking station in VHF, UHF, L,S,X band**
- **Antennas and arrays – design, mesurement, production**
- **High speed comunication transiver DVB design, test, production**
- **Soft Defined Radio core and FPGA integration with image sensor**



# O & K co. Acceco systems capabilities



# Point- L

**Automated Design of Control Systems**  
**New project on**  
**Satellite test bed tester Systems**  
**Within CASTRA**

# The Company

Point L - Bulgaria Ltd. is an engineering company established in 1991 with the mission to develop and provide innovative software and hardware products for process control application.

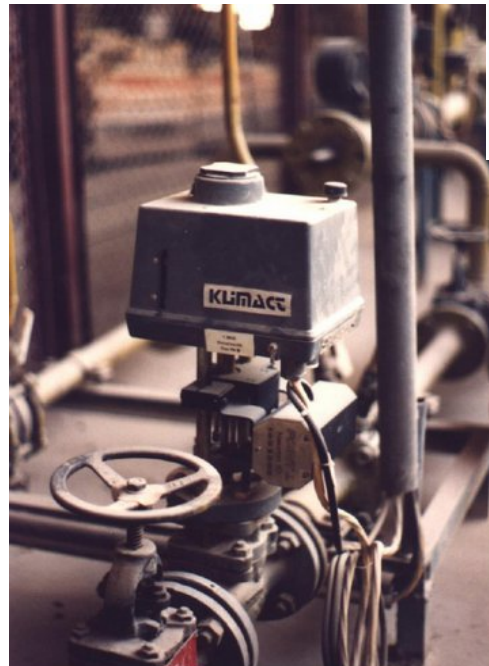
The Company's products make up a complete set of software tools and intelligent devices for design, implementation, monitoring and support of open process control systems. The set includes: CASE designers for analysis and automated design of control systems; SCADA System; Software tool for administration of industrial networks; intelligent actuators' controllers, based on a patented method for contactless reading of the position; intelligent hybrid input-output modules; gateways; active sensors; other.

The Company has completed numerous automation projects across an array of industries, countries and clients.

# Point L Intelligent Actuators' Control

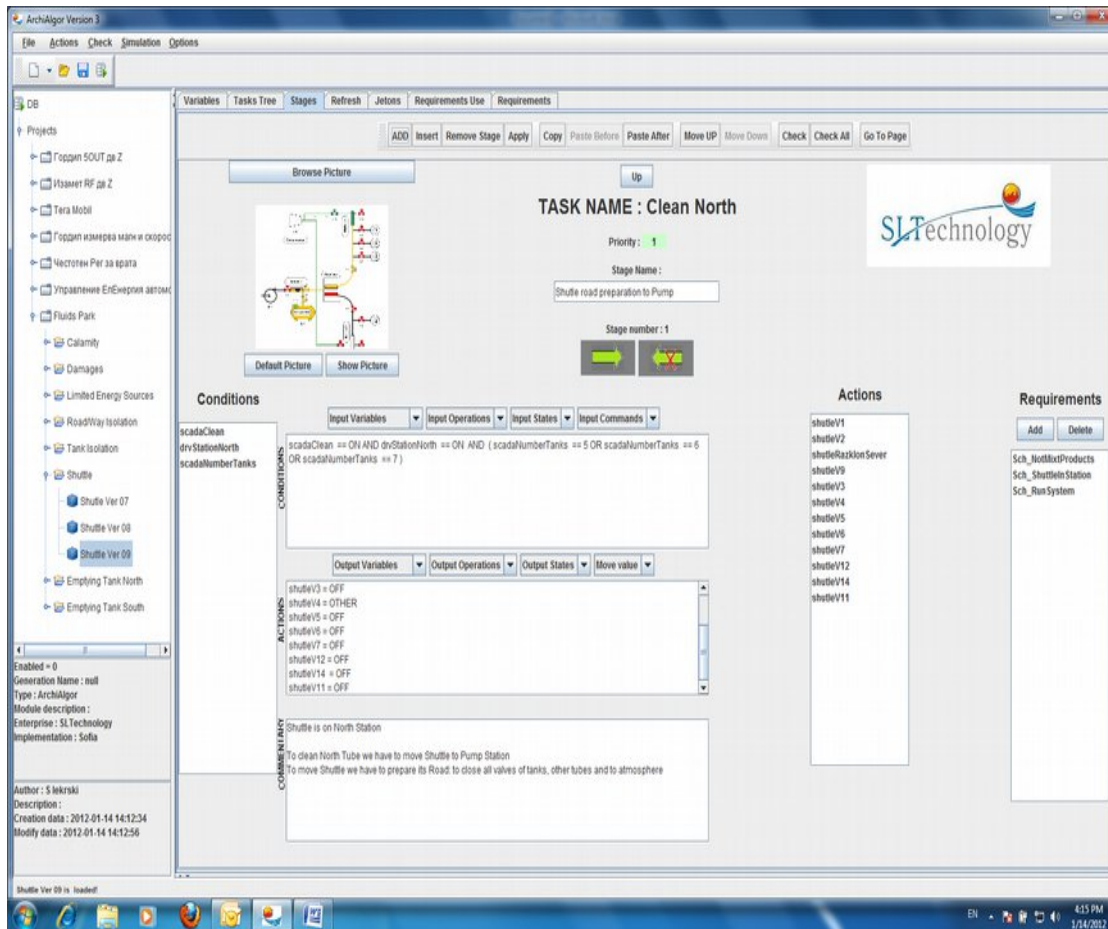
Non-contact Position  
Readout and Control  
Functional diagnostics and  
control incorporated in  
actuator

Application range - all  
actuator types, new and  
used





# The Company offers a Computer-Aided Software Engineering Designer ArchiAlgor for automated design and commissioning of satellite and ground station control systems

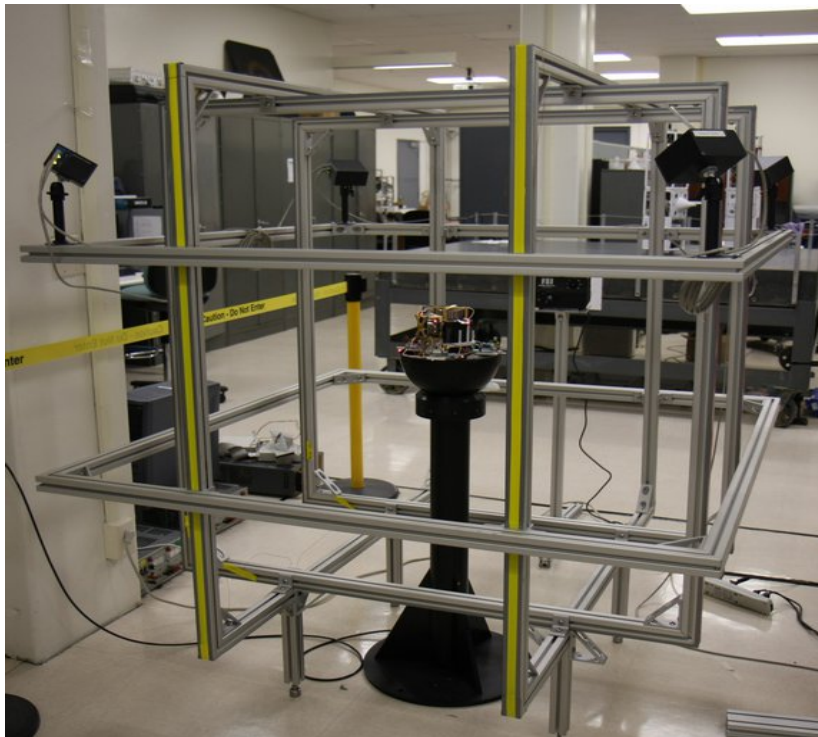


ArchiAlgor is based on an innovative **engineering approach**, enabling analysis, structured description and solution of critical control tasks

Main advantage of said method is that it creates priorities of activities, resulting in **greater reliability** and **performance** of control systems

This tool helps build a priority mechanism, complements specification through process analysis, implements technical requirements, creates a modular program structure

# New project for designing of a test bed for testing microsattellites' attitude control-orientation and stabilization



illustration

"Point L- Bulgaria" Ltd., in collaboration with the company "Micro plus-Apostolov" Ltd. , Sofia University and other members of the cluster CASTRA, began development of a innovative modular test bed with three degree of freedom for testing the attitude control an orientation and a stabilization of microsattellites or separate satellites components. The installation will shorten tests of the behavior of satellites in orbit by simulating the magnetic and radiation effects and by monitoring the reaction of the on-board control system. It will increase the objectivity of the assessment of performance of satellite systems.

# Micro-Plus Apostolov

**Precision mechanical systems and  
equipment;  
Key supplier in CERN projects**

## Activity

- Design of mechanical parts, modules, systems and equipment mainly for high accuracy and reliability requirements purposes. The equipment is either with high-tech production purposes, automation processes, or automation of the measuring technologies.
- Optimization and modernization of existing mechanisms and machinery.
- Unique equipment including for scientific researches.
- Design of products and devices in serial production.
- Consulting activity.

## Our competitive advantages

- Our team has about 45 years of professional experience mainly in design of systems and equipment for high-tech production and processing.
- In accordance with the requirements of the specific project, certain design rules and principals are applied, including exact constraint design, error minimizing principals for the entire system.
- We are knowledgeable of the classical mechanical technological abilities (including the limit abilities) as well as of the recent micro mechanical technologies.
- Optimization and computer design feasibility of different elements and modules qualities.
- Excellent relationship with companies with similar activity as well as with hardware and software professionals.
- Excellent relationship with Bulgarian technical universities, related with design of precise mechanisms and machines, and high vacuum equipment.
- Excellent relationship with companies for mechanical parts manufacturing.
- Our experience and organization of work allows us to participate with competitive solutions related to the full implementation of tasks including design, mechanical systems engineering supporting of production (providing technological, measuring, control and specialized tools), manufacture, installation and testing.

1. Participation in the project XFEL (in DESY Hamburg Germany)-since 2005 and currently



Fig. 1.1 design and manufacturing of the power divider (high energy) and RF phase shifter

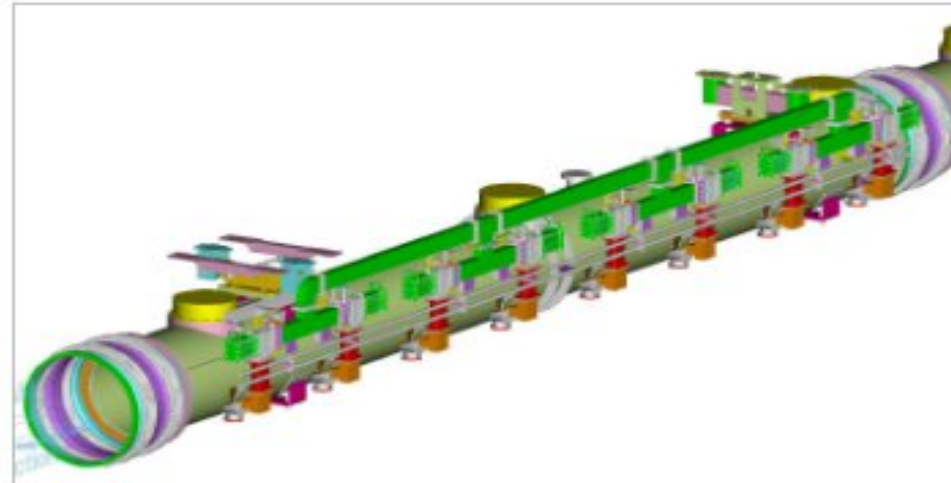
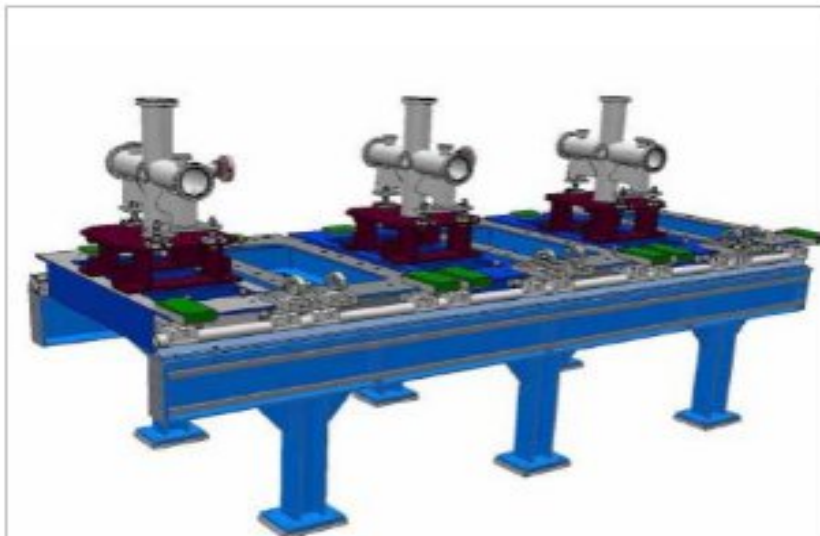


Fig. 1.2 Support system for waveguide distribution systems with kinematic type links

2. Engineering support for manufacture, measuring and installation of prototype models for the project SPIRAL2.



**Design, fabrication and installation  
of the mechanical system of  
"Ge detector for gamma radiation"  
-project funded by the European  
programs. Mechanical structure is  
protected by two European patents**

**Design of the mechanical  
system for specialized  
equipment for microelectronics**

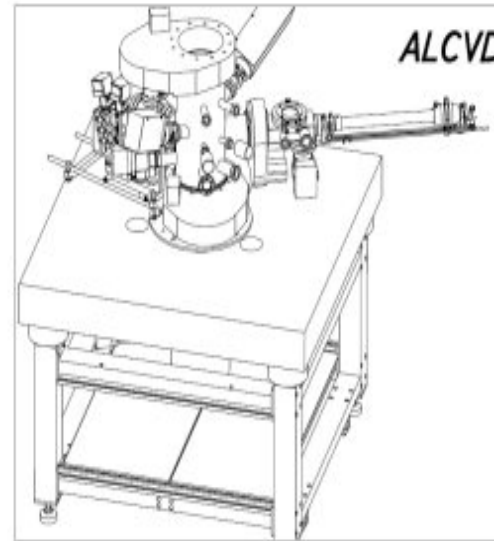
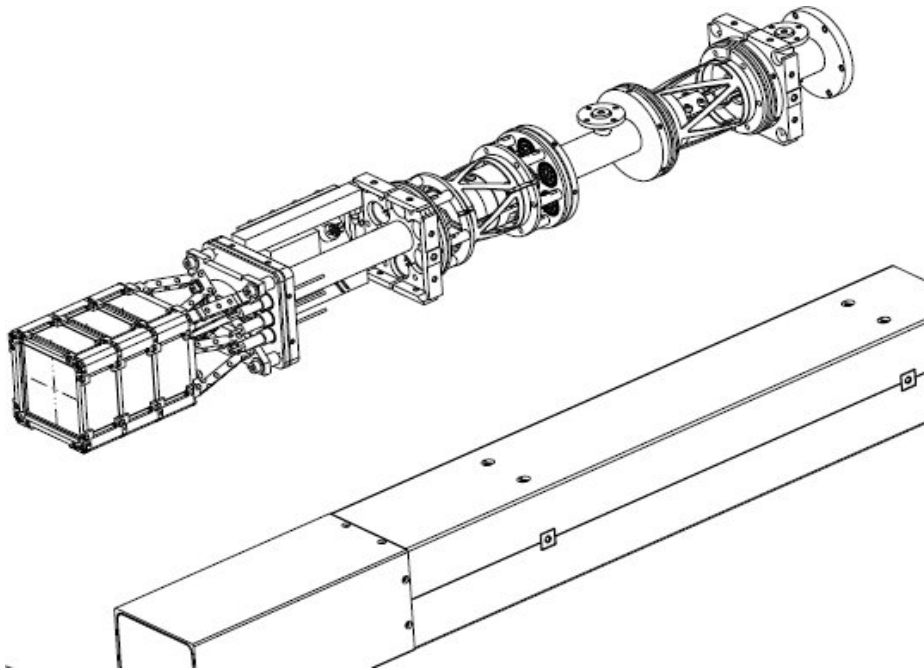


Fig.4.1 Experimental equipment for  
Atom Layers CVD

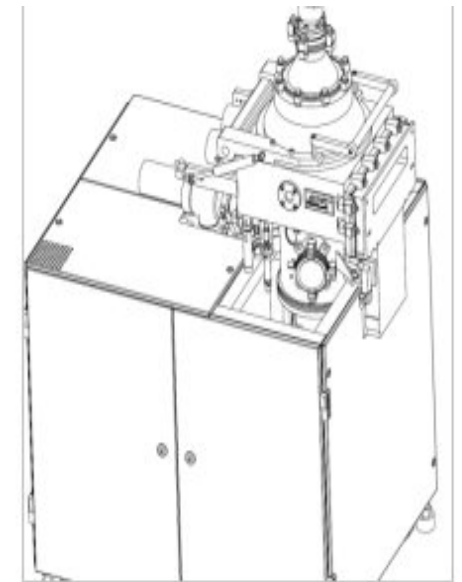


Fig.4.2 Experimental equipment  
for plasma etching

# TELESYS Ltd

**Avionics, Flight Control and Navigation  
and Communication**

**Systems Design and manufacturing;  
UAV systems design, manufacturing and  
operation;**

**Key Supplier to the Ministry of Defense  
for UAV JET and radar systems**

## TELESYS Ltd. - Some projects



Jet UAV shooting targets

**NATIONAL IFF/SSR SYSTEM UPGRADE  
with NATO interoperability**  
(Telesys Ltd., BAS SRI, Bitova Electronika AD)



- **MOBILE COMMUNICATION MODULES  
for emergency situations**  
(Telesys Ltd., BAS-IPP, Civil Protection Agency)



- Interrogator Units Supplier –  
EADS / Defense Electronics
- Producer  
EADS DS Belgium NV Oostkamp



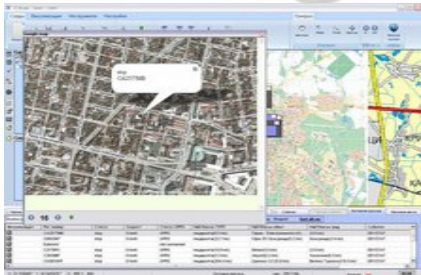
# ELECTRONINVEST

**Navigation Systems design and applications in Automotive and aviation sectors;**

**Design and Manufacturing of electronic systems and precision sensor networks**

# ELECTRONINVEST

Dedicated GPS/Galileo/Glonass tracking solutions- R&D, development , manufacturing and operation of such networks

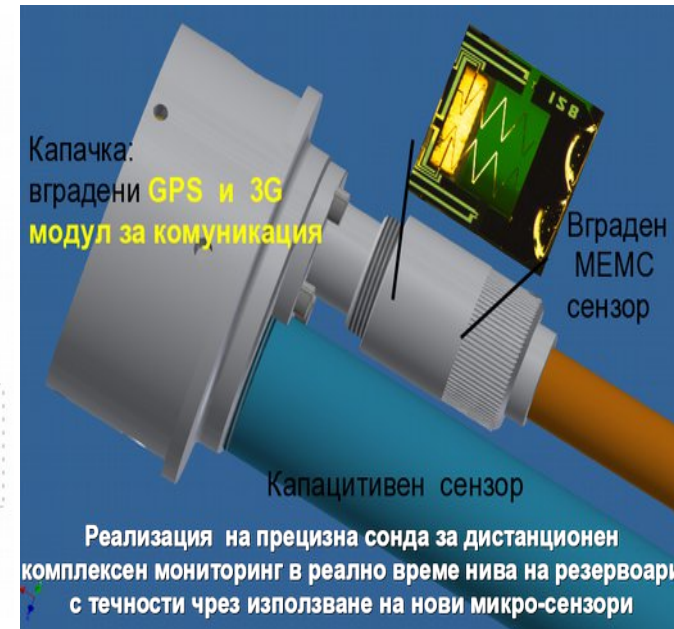
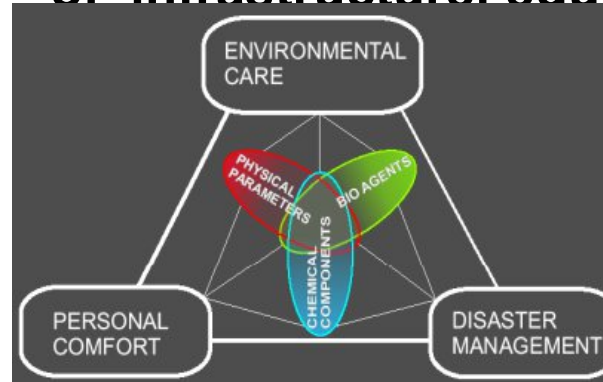


Emil Danev

Integration with custom or existing sensor networks for remote monitoring and control

# sime-mys

Intergarted Sensor networks for remote envoronmental and industrial monitoring of infrastructure, equipment and other



Реализация на прецизна сонда за дистанционен комплексен мониторинг в реално време нива на резервоари с течности чрез използване на нови микро-сензори

# Green Embedded Systems / ESA 2014



# Experience and Expertise

- Embedded software design and development
  - MCUs - Cortex M4, M3, M0, M0+, MSP 430
    - Freescale, ST, Texas Instruments
  - MPUs - i.MX 23, i.MX 27, i.MX 28, i.MX 31, i.MX6
- Radio communication (sub-GHz, 1-GHz, 2.4GHz, Wi-Fi)
  - Texas Instruments – CC2538, CC3100, CC3200
  - Semtech – SX1272
- GSM/GPRS – u-blox, Quectel
- PCB design, development and layout
- Embedded OS
  - Linux - Board bring-up, Device drivers, Toolchains, OpenEmbedded, Yocto, Custom Board Support Packages (BSP), User-space application development
  - Contiki OS – 6LoWPAN IP radio mesh networks for embedded applications
  - Quantum Leaps QP platform (state-machines for embedded software applications) – **proven in aerospace, medical and industrial applications**
- Programming languages – C/C#, Python, Java, Javascript, C#
- Databases – CouchDB, SQLite, MySQL
- Mobile Apps – Android and iOS

# Noteworthy projects

- Web based AMI (Automated Metering Infrastructure) system, CloudAMI – complete family of Linux based meter controllers using Wi-Fi, Ethernet, RF and GPRS + cloud based server and client application
- Integrating CloudAMI smart metering platform into Nokia-Siemens mobile billing system (Cumulocity) for creating pre-paid energy system and general M2M communication platform
- Home and Industrial Lighting management and control system (Cortex M3 MCU's to control the LED drivers and 6LoWPAN to communicate with the outside world + Sencha Touch 2 mobile app to control the lights and communicate with the LED drivers) for Earns Technologies (Hong Kong)
- STAP GNSS receiver
- Web based Vehicle Tracking System
- Complete Linux BSP for i.MX27 based weighing scale for Avery Berkel (England)
- Board bring-up for Linux / i.MX28 based industrial controller for TekPartner (Denmark)

# Ultra-compact embedded Linux controllers



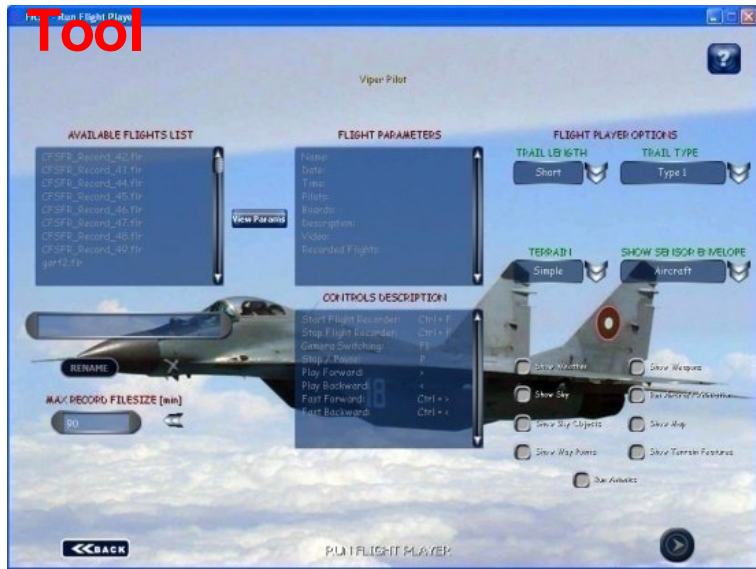
# SimSoft Ltd

**Design, manufacture and custom software solutions for simulation and training, incl. UAV flight control systems;**

# SIMSOFT

## FR3D – Flight Recorder

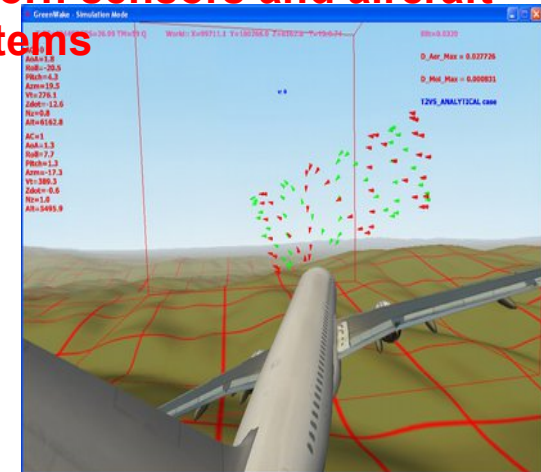
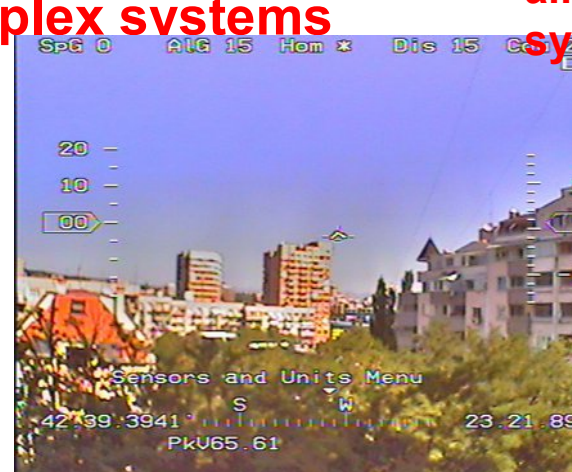
## Example



## Tactical UAVs-frames

## Control and management software for complex systems

## real-time data processing and visulisation from airborne sensors and aircraft systems



# Bulgarian Association for Modeling and Simulation



# Cyber-security training and infrastructure



MTITC 2011



MOD



National Revenue  
Agency 2014

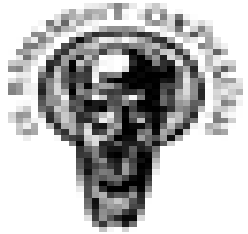
## Areas of expertise

- **Software systems development for the needs of cyber-security and crisis management trainings**
- **Software tools in support of the decision making process in crisis management**
- **Application of tools and systems for modelling and simulation in the decision making process at operational and tactical levels in warfare**
- **Modelling and simulation of natural disaster events and processes**
- **Development of virtual reality tools**
- **Aerospace Mission design**
- **Business process simulations**

# Radio Engineering Department of the Physics Faculty, Sofia University

**High-Speed Satellite communication systems  
and antennas;  
RF plasma micro-thruster development**

# Design and manufacturing of low-profile satellite communication antennas

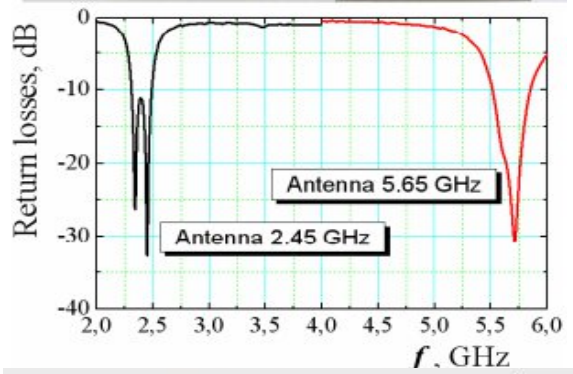
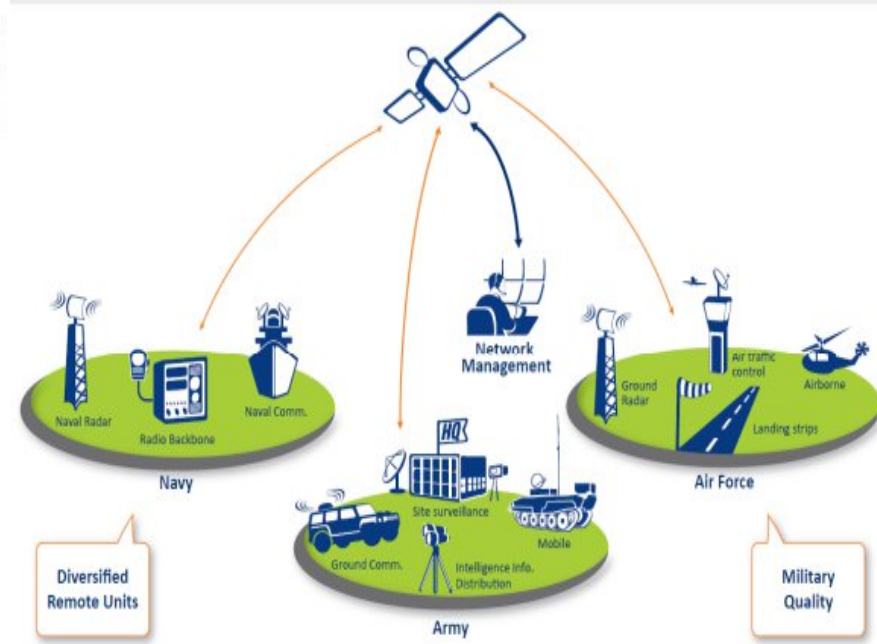
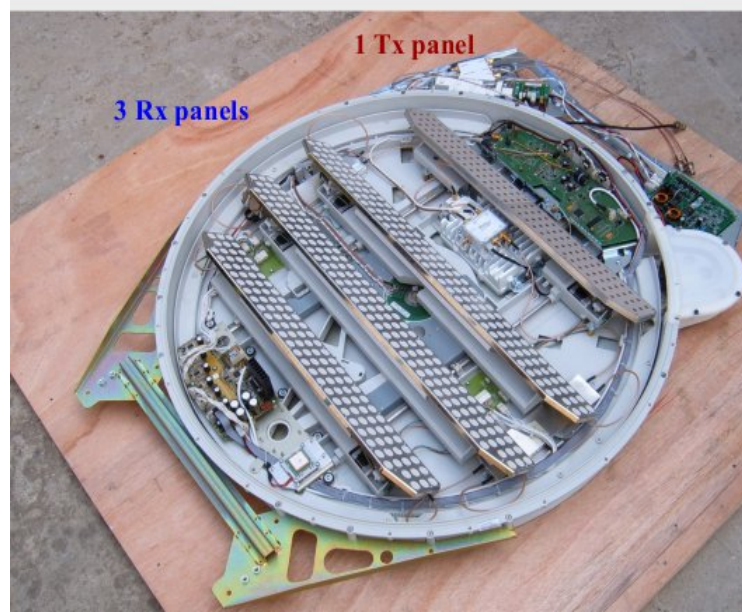
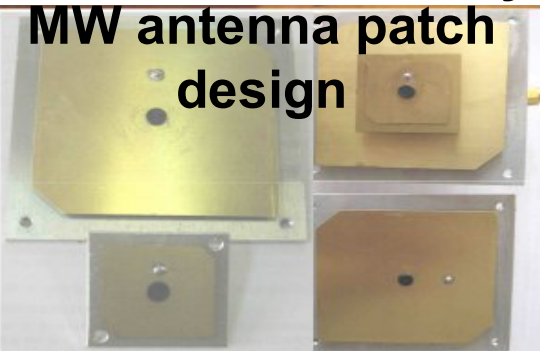


Sofia University  
Department of  
Physics

ANTENNA SYSTEMS  
**RaySat**  
Satcom on-the-move

Example: multi-panel 2-way communication antenna (the so-called "mobile VSAT")

MW antenna patch design



Fully flat panel



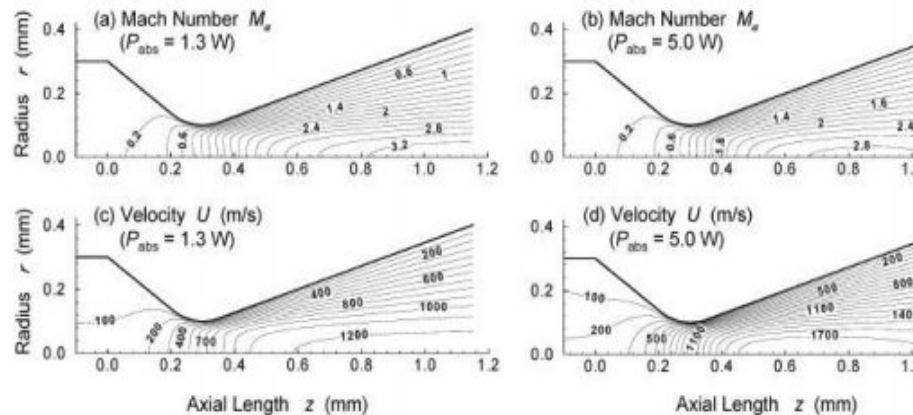
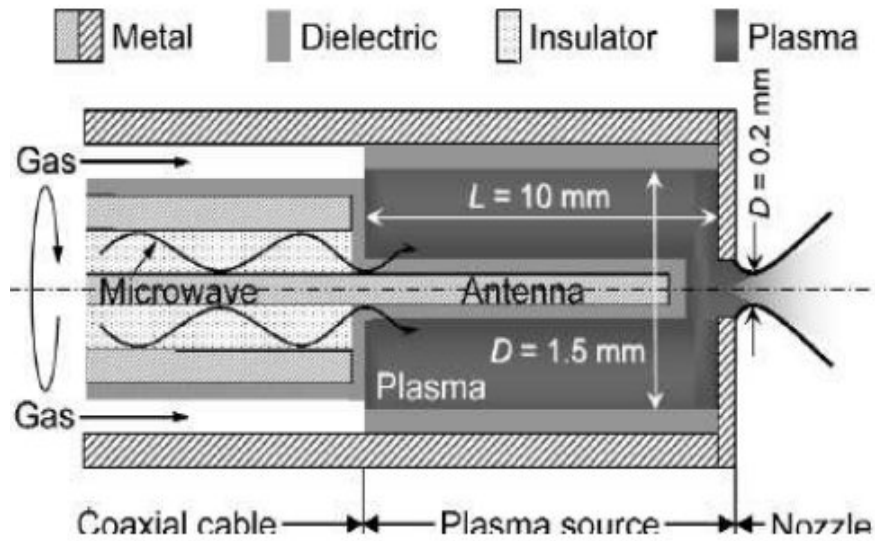
Single inclined panel



Multi-panel antenna



## Microwave Plasma Micro-Propulsion System development at Sofia University

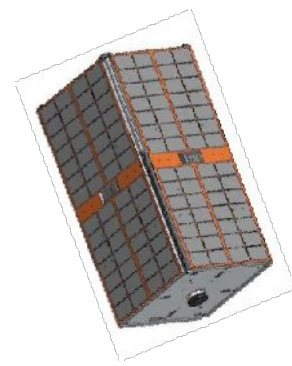


The developed Ar gas pulsed plasma source produces dense plasma with high gas temperature  $T_g \sim 1500-3000K$ . When used with a basic Laval-type nozzle, achieves maximum jet velocity estimated at  $v \sim 1000-2000$  m/s (hypersonic) at atmospheric pressure. The calculated maximum thrust at gas flow rate 150sccm is in the range 4.5-9 mN and the specific impulse is in the range 105-210s. This parameter shows that our electrothermal thruster is suitable for realization of an orbital maneuver of a microsatellite ( $\sim 30$  kg) with achieved  $\Delta v \sim 13-26$  m/s for 24-hour period. Dimensions 2cm X 0.3cm X 0.3cm,  $f=2.45$ GHz, ceramic tube,  $P < 10W$  both in continuous and pulse regimes

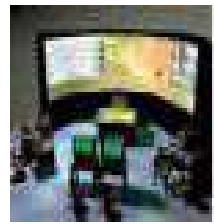
Assoc. Prof. J. Kiss'ovski, Sofia University

- **General information about CASTRA**
- **Some selected areas of expertise**
- **Small Satellite project for ICT applications**

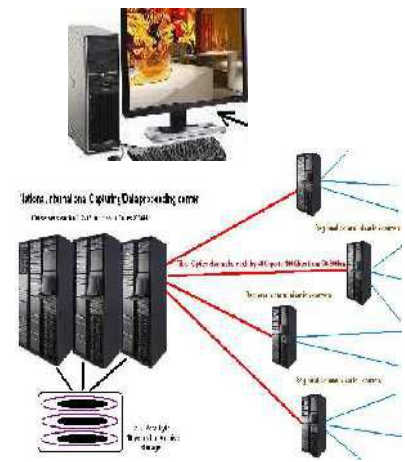
## Components of a satellite based ICT system



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- Minisatellite** <1000 kg
- **Microsatellite** <100 kg
- Nanosatellite** <10 kg
- Picosatellite** <1kg

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

**data and**

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

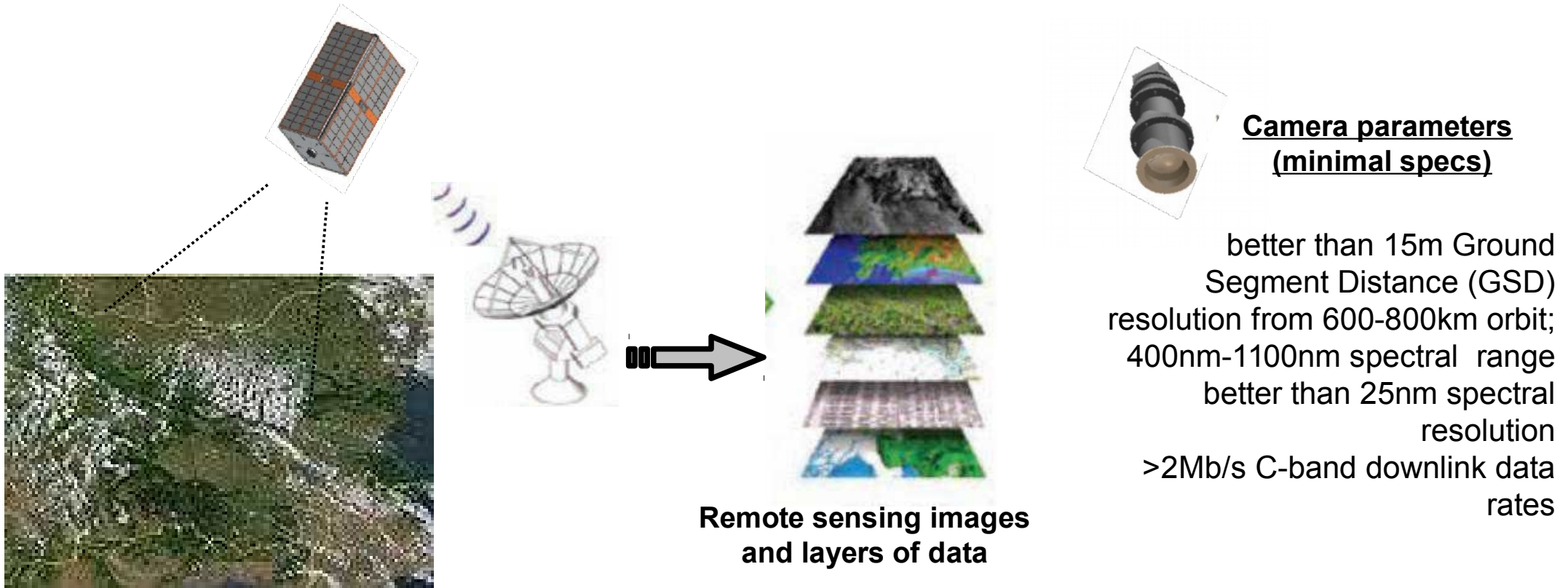
**Qualified and motivated team of trained specialists**

**The development and integration of all components require close cooperation and joint effort from organizations with complementary expertise**

## Application №1:

Remote sensing of Earth surface with a Hyperspectral digital camera and generation of information content images for the needs of specific users:

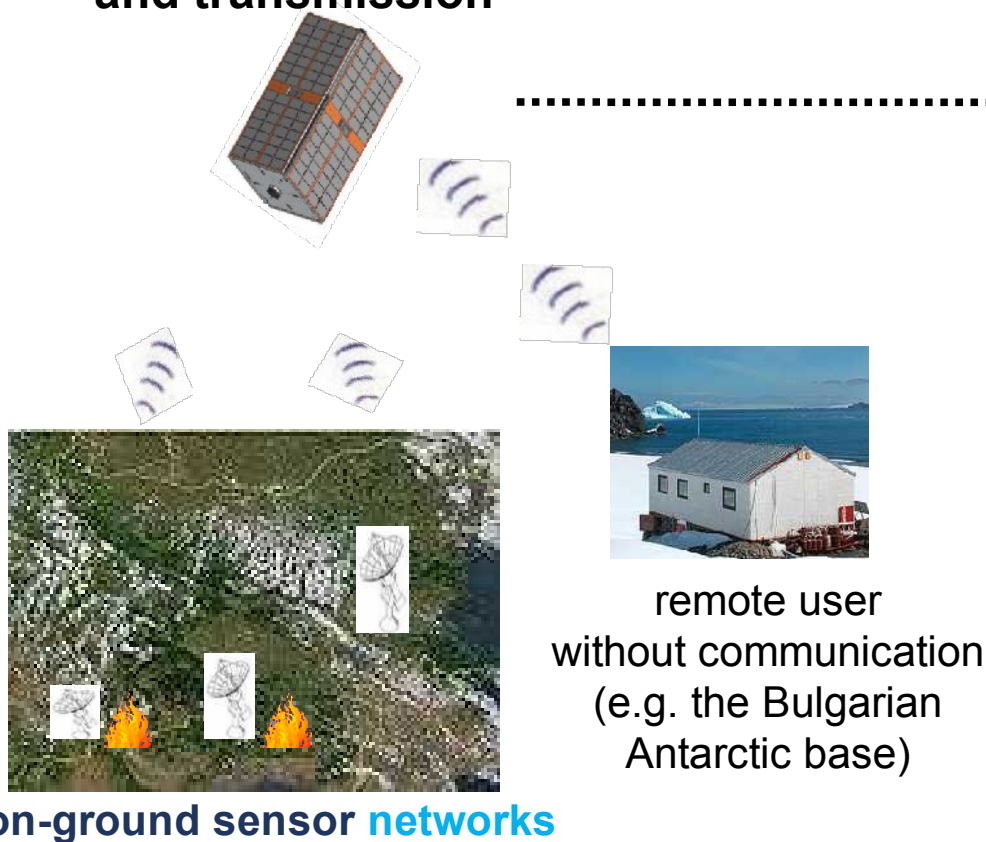
*Control of vegetation cover, land and water surfaces, industry and ecology driven monitoring, security and other...*



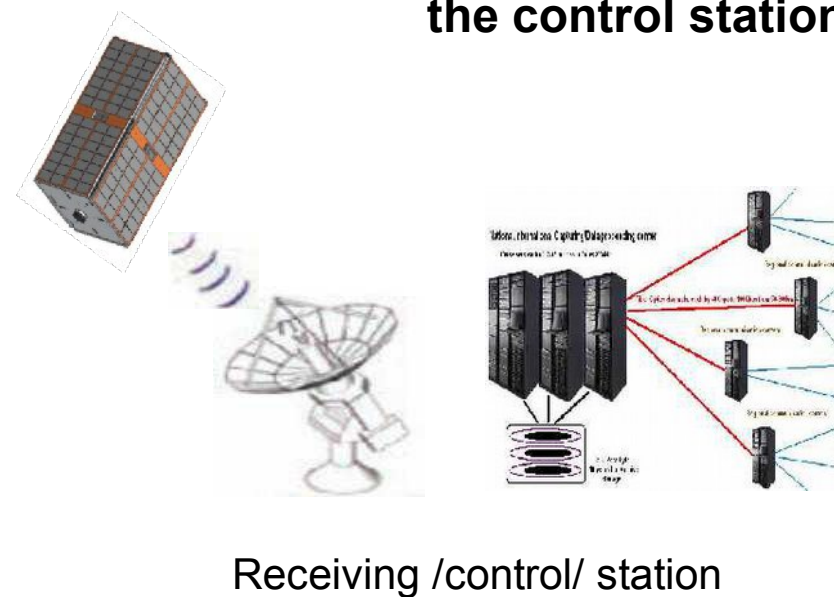
## Application №2:

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

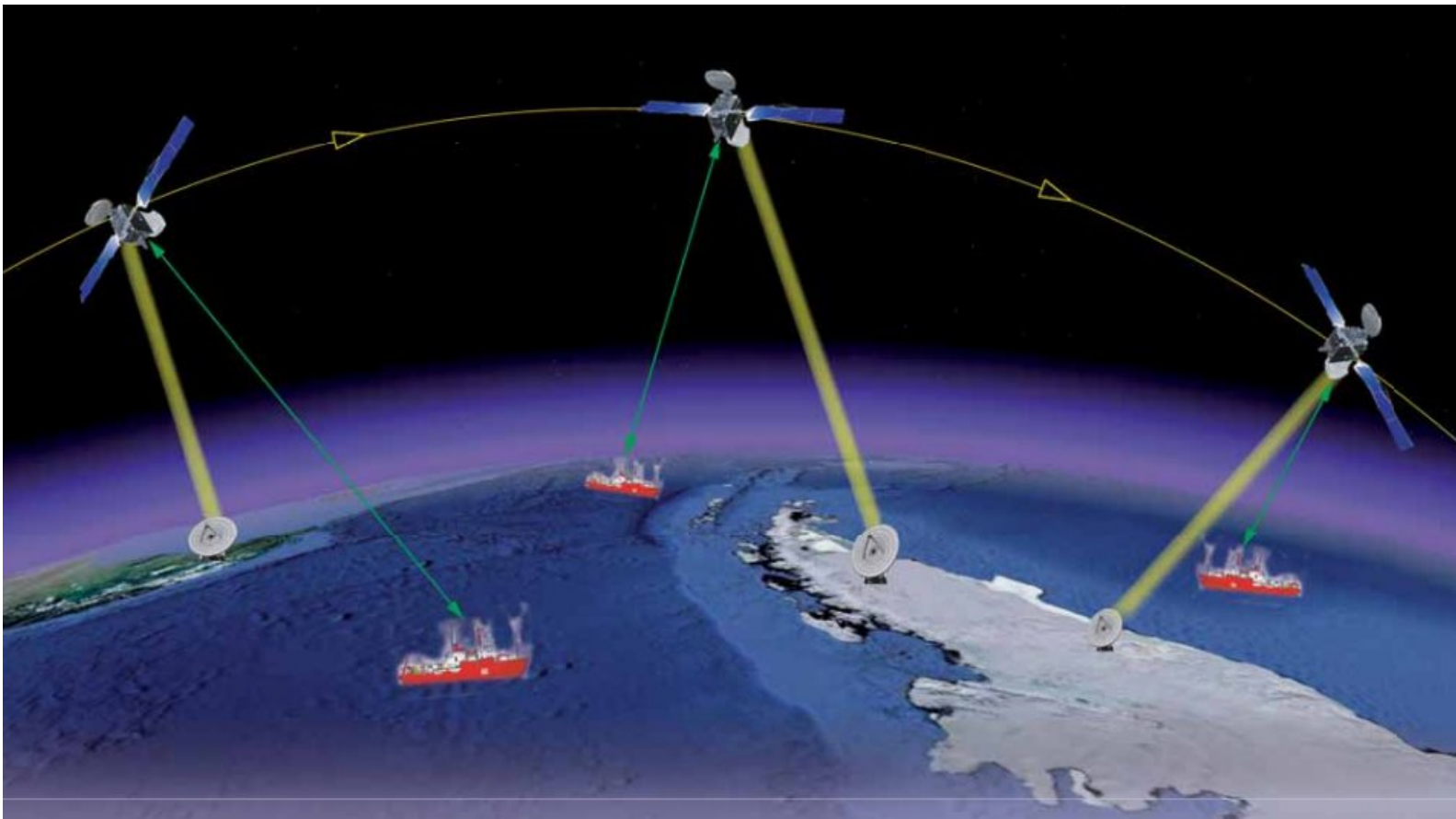


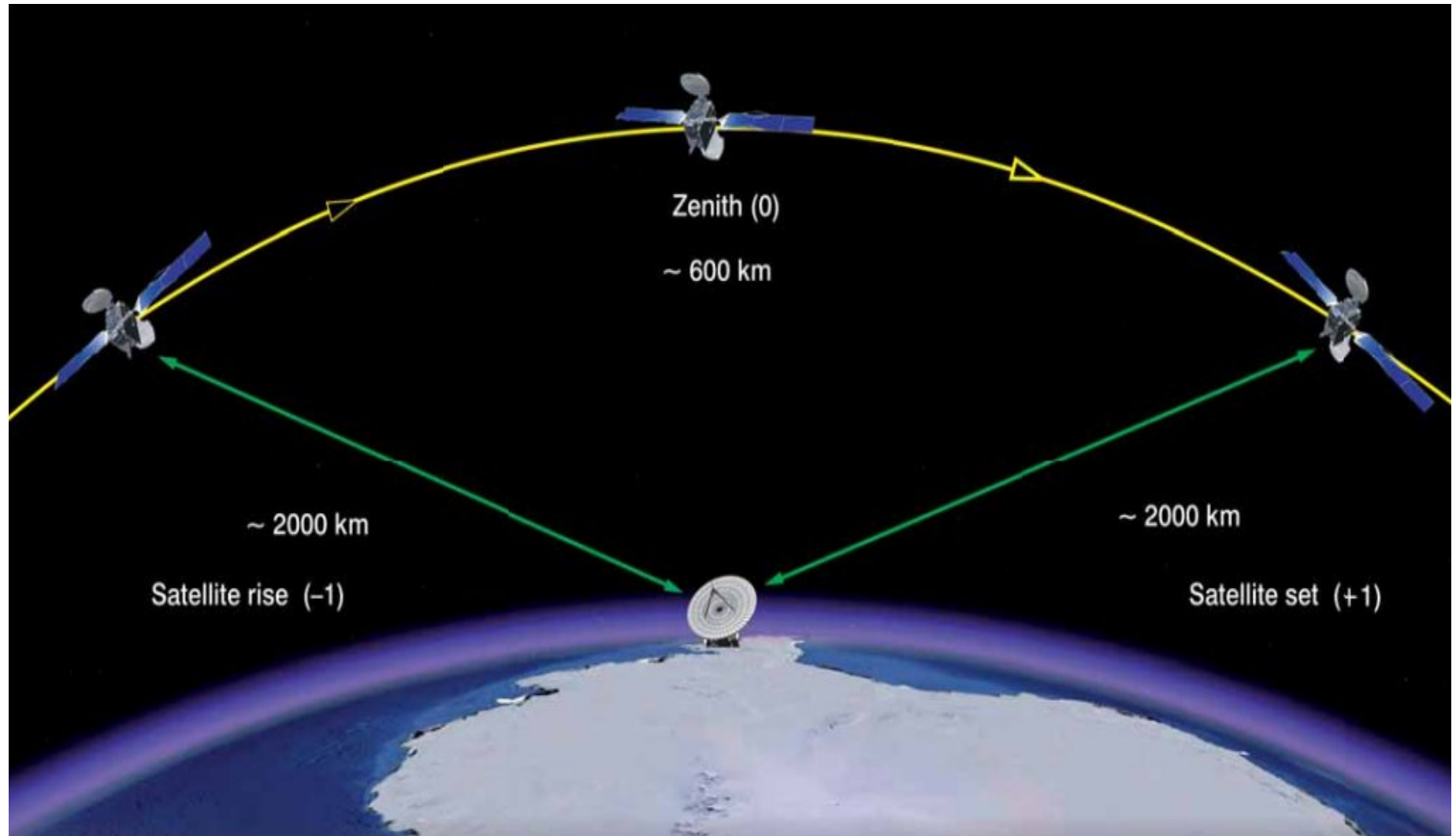
**Position 2:** data download/upload at the control station



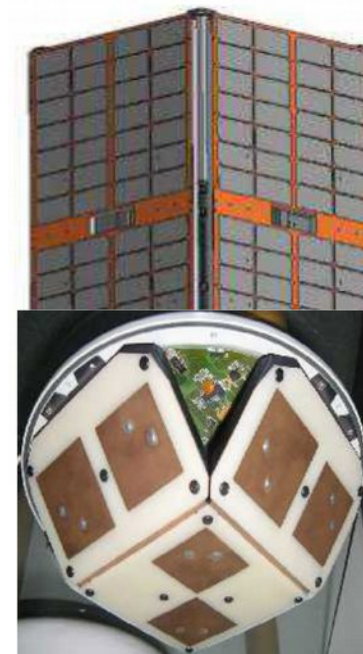
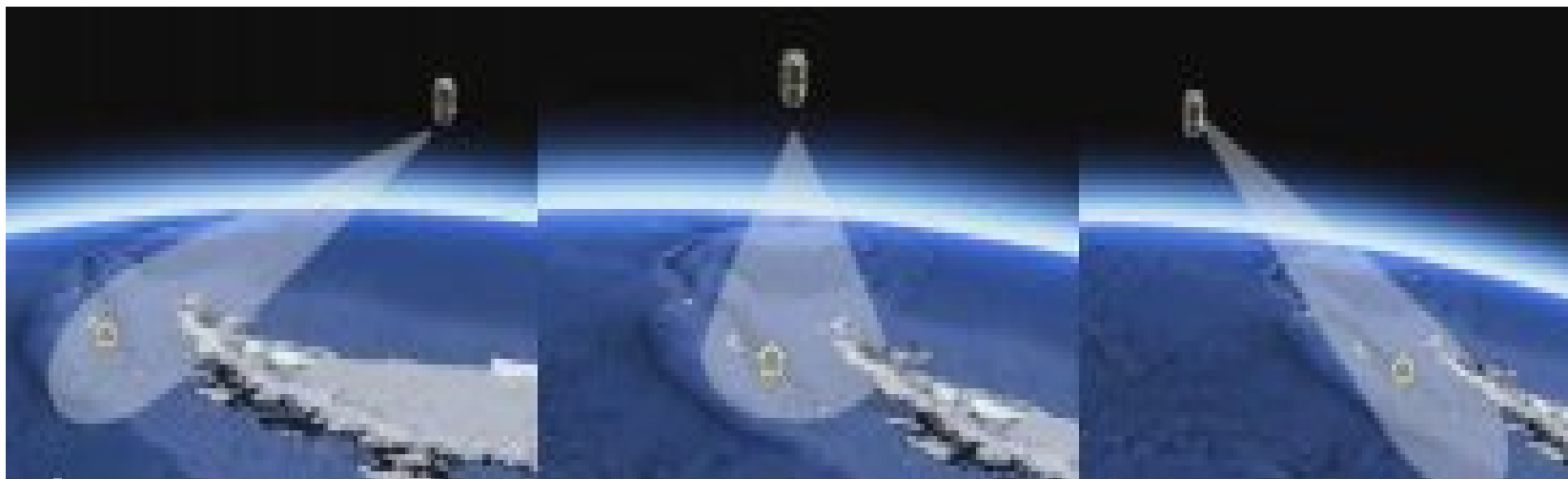
## *Application №3:*

**Land and Sea tracking of vehicles, humans, cargo, and other objects for the purpose of security, logistics, research etc ..**





Total data volume for a single communication session is evaluated at ~100 MB for the uplink channel and ~300 MB for the downlink channel. More than 1-2 communication sessions per day could be established using more than 2 ground stations. In case of a need to transmit more data through the downlink channel (for example: high-resolution satellite images), data-transfer speed increase of ~50% could be achieved if simple unidirectional data-transfer protocols are used.



Using switchable or steerable antennas for both, Earth and satellite stations, the period „visibility“ time for high-speed data transfer could be increased up to 9-10 min per session.

Channel	$f$ , GHz	Case description	Losses, dB	Carrier/noise $C/N_0$	Bit rate $r_b$
Uplink (case 1; narrow-beam Earth antenna 1.2 m; steerable)	2.4	EIRP (Earth antenna) 26.5 dBW (50 % efficiency; standard power 1 W); Satellite antenna $G/T = -16$ dBK; $E_b/N_0 = 9.5$ dB; reserve 3.5 dB	-155.6 dB (600 km) -160 dB (2000 km)	83.5 dBHz (600 km) 73.1 dBHz (2000 km)	11.2 Mb/s (600 km) 1.023 Mb/s (2000 km)
Uplink (case 2; wide-beam Earth antenna)	2.4	EIRP (Earth antenna) 9.5 dBW Satellite antenna $G/T = -16$ dBK	- " -	66.5 dBHz (600 km) 56.1 dBHz (2000 km)	223.8 kb/s (600 km) 20.4 kb/s (2000 km)
Downlink (case 1; narrow-beam Earth antenna 1.2 m; steerable)	8.2	Gain (satellite antenna) 7.5 dB; power 4 W; Earth antenna $G/T = 14.2$ dBK; $E_b/N_0 = 9.5$ dB; reserve 3.5 dB	-155.6 dB (600 km) -160 dB (2000 km)	98.7 dBHz (600 km) 88.3 dBHz (2000 km)	37.15 Mb/s (600 km) 33.8 Mb/s (2000 km)
Downlink (case 2; wide-beam Earth antenna)	8.2	Gain (satellite antenna) 7.5 dB; power 4 W; Earth antenna $G/T = -13.5$ dBK	- " -	71.5 dBHz (600 km) 60.9 dBHz (2000 km)	708 kb/s (600 km) 61.6 kb/s (2000 km)

Assoc. Prof. P.Dankov, Sofia University

## Mission Design - Case study application – Bulgarian Antarctic base coverage



Fig. 1. a) Antarctic map and the position of Livingston island; b) Bulgarian base; c) Typical meteorological station

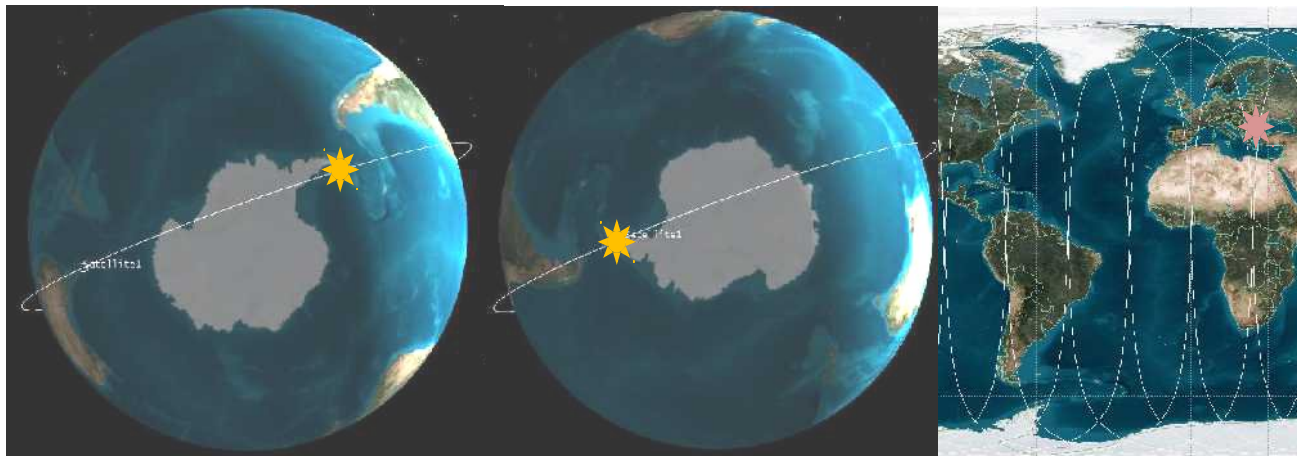


Fig.5.Simple orbit investigation (Sofia and Livingston Island are marked)

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



## Mission Idea Contest for Micro/Nano Satellites Utilization

### Certificate

This is to certify that

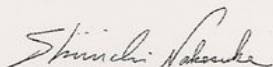
Plamen Dankov, Mario Gachev, Vesselin Vassilev,  
Kaloyan Zlatkov, Zhivko Kiss'ovski, Dragomir Mateev,  
Ognyan Ognyanov, Iliyan Krassimirov, Cvetan Simeonov  
from

Sofia University "St. Kliment Ohridski"

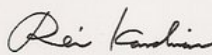
were selected as Semi-Finalist of  
the 2nd Mission Idea Contest for Micro/Nano-satellite Utilization  
with the submission entitled:

Sofia University SAT (Small Communication Satellite  
Mission for Enhancement of Antarctic Investigations)

On July 1st, 2012 in Tokyo, Japan.



Shinichi Nakasuka  
General Chairperson,  
The 2<sup>nd</sup> Mission Idea Contest  
for Micro/Nano Satellite Utilization,  
The University of Tokyo,  
7-3-1, Hongo, Bunkyo-ku, Tokyo 113-8656  
Japan



Rei Kawashima  
Secretariat,  
Mission Idea Contest Office,  
University Space Engineering Consortium,  
2-3-2, Yayoi, Bunkyo-ku, Tokyo 113-0032  
Japan



The 2<sup>nd</sup> Mission Idea Contest is  
Organized by University Space Engineering Consortium  
Supported by United Nations and International Academy of Astronautics



UNITED NATIONS



International  
Academy of  
Astronautics

Our Satellite Mission and Design  
was selected as a semi-finalist  
among other 77 projects from 53  
countries in the International  
Mission Idea Contest – 2012,  
Tokyo, Japan

**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***