CASTRA capacity and current projects in space

Vesselin Vassilev, PhD
CEO

info@castra.org

2016

www.castra.org

Content

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

Who we are?

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 of 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 benefits of society and citizens.

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 on Earth from developing novel upstream space technologies and their downstream applications.

CASTRA members

(click on the titles to open each organization site)

Companies

- Aegis Ltd.
- Telesys Ltd.
- Novorell Ltd.
- Lumycomp Design Ltd.
- SimSoft Ltd.
- BMG Bulgaria JSC
- PointL-Bulgaria Ltd.
- MicroPlus Apostolov Ltd.
- ElectronInvest Group Ltd.
- KONTRAX JSC
- O &K SD
- Mozaika Co Ltd.
- Green Embedded Systems Ltd
- SSTL Ltd. (UK)

14

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

4

NGO's

- Remote Sensing Application Center-ReSAC
- Bulgarian Modeling and Simulation Association "BULSIM"

2

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

main Academic and R&D Institutions working with CASTRA

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

Map of CASTRA members across Bulgaria

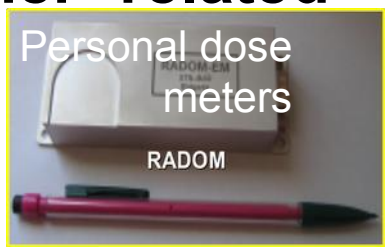
Some selected areas of expertise

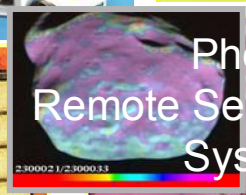
(Additional information available on request)

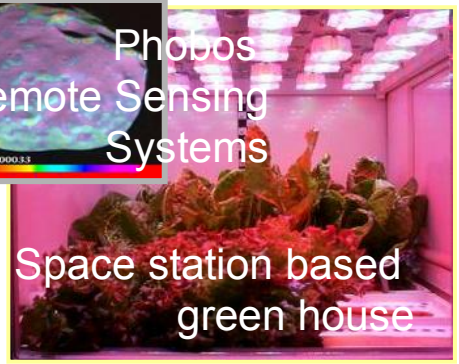
Background

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

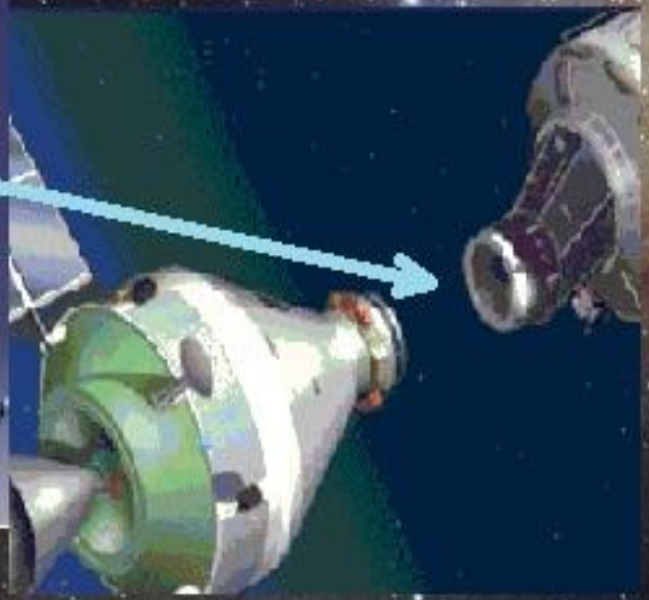
Electronics, IC design, automation, robotics, UAV systems, high-speed satellite communications, software and embedded systems and other.

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 years

- Official CREE LED Solution Provider for East Europe
- FP7 BG161PO003-1.1.05-0187 project – EU funded for Light Measurement laboratory

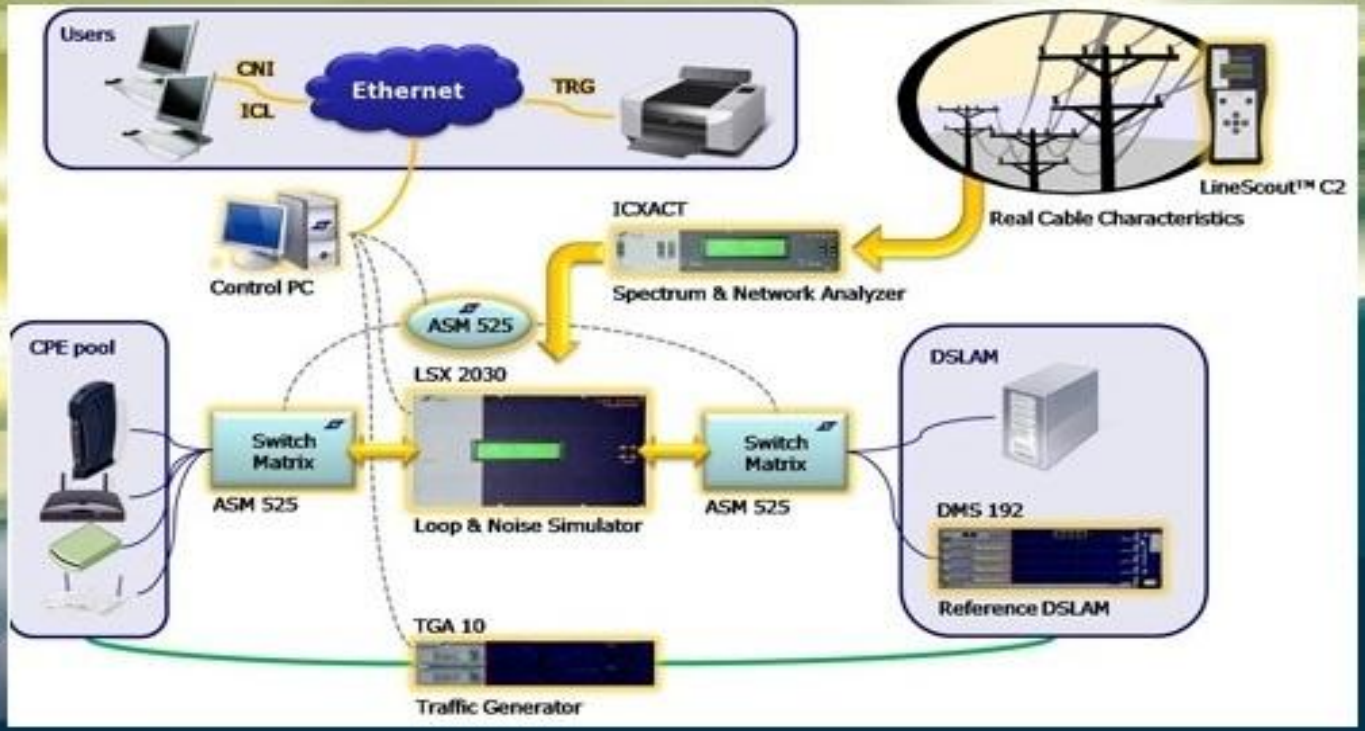
- H2020, EU funded project – OPTINTEGRAL – advanced displays
- OEM electronic design and production – PCB design, production assembly and testing.

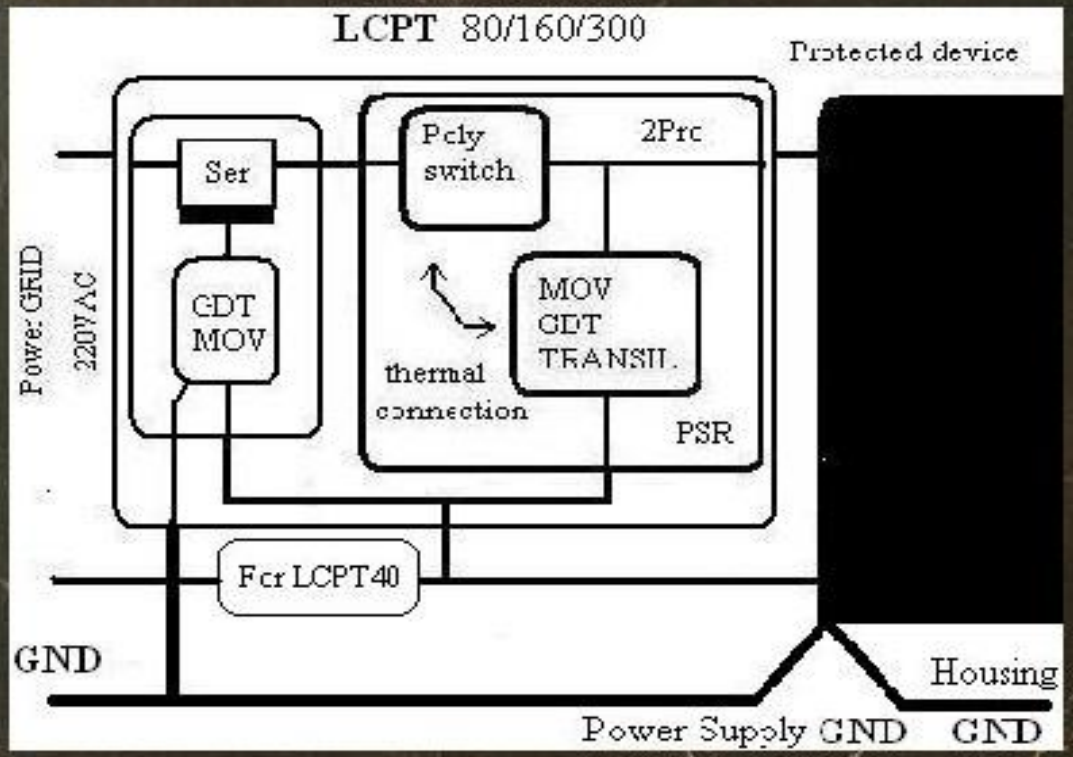
LumyComp Design

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, Vitese / Broadcom / Lantiq chipset based.



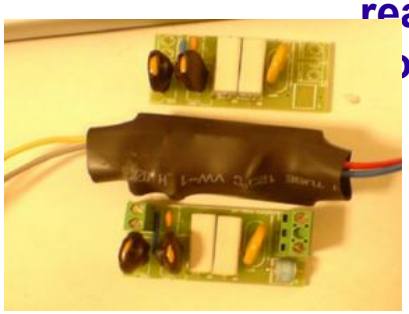


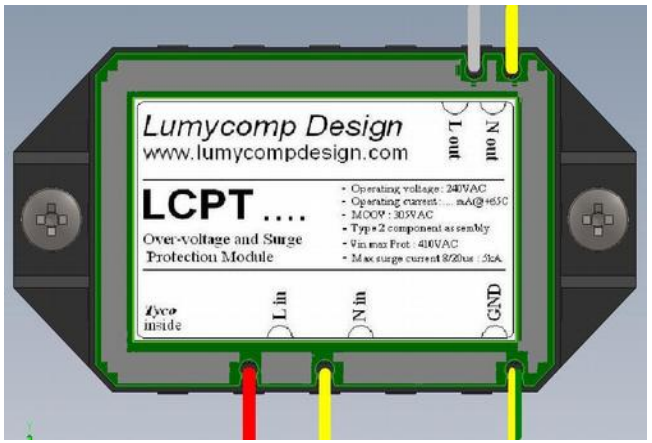
LumyComp Design

- 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

Lumycomp

The professional LED devices

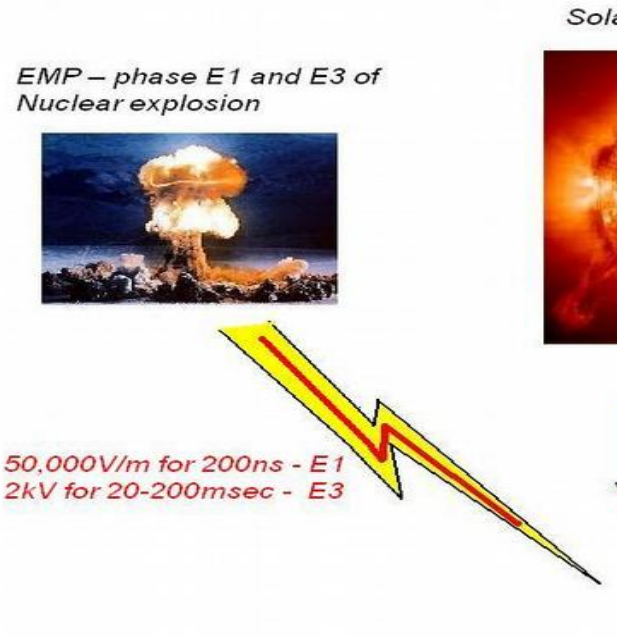




Industrial LED lighning and control systems development for high-realiability and high- spec applications

(e.g. past project underwater LED lighning 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



Novorell Technologies Ltd

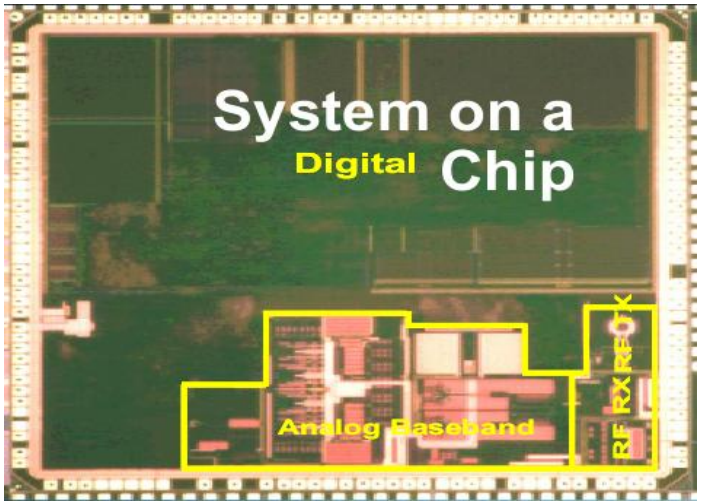
novorell technologies

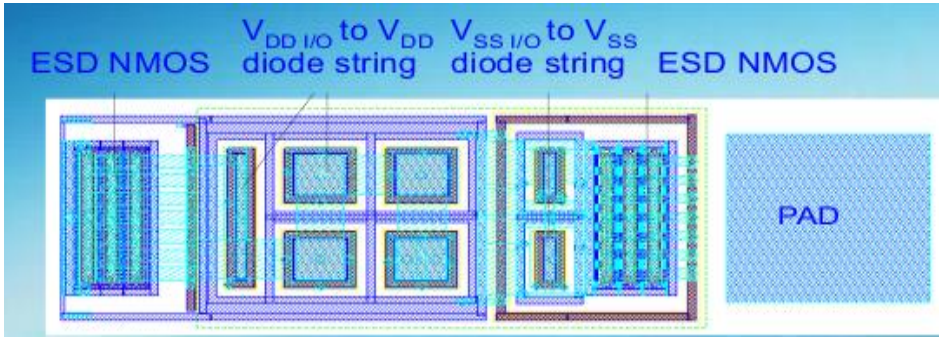
Integrated Circuits design for high-reliability (e.g, radiation hardness) for space applications (ESA projects)

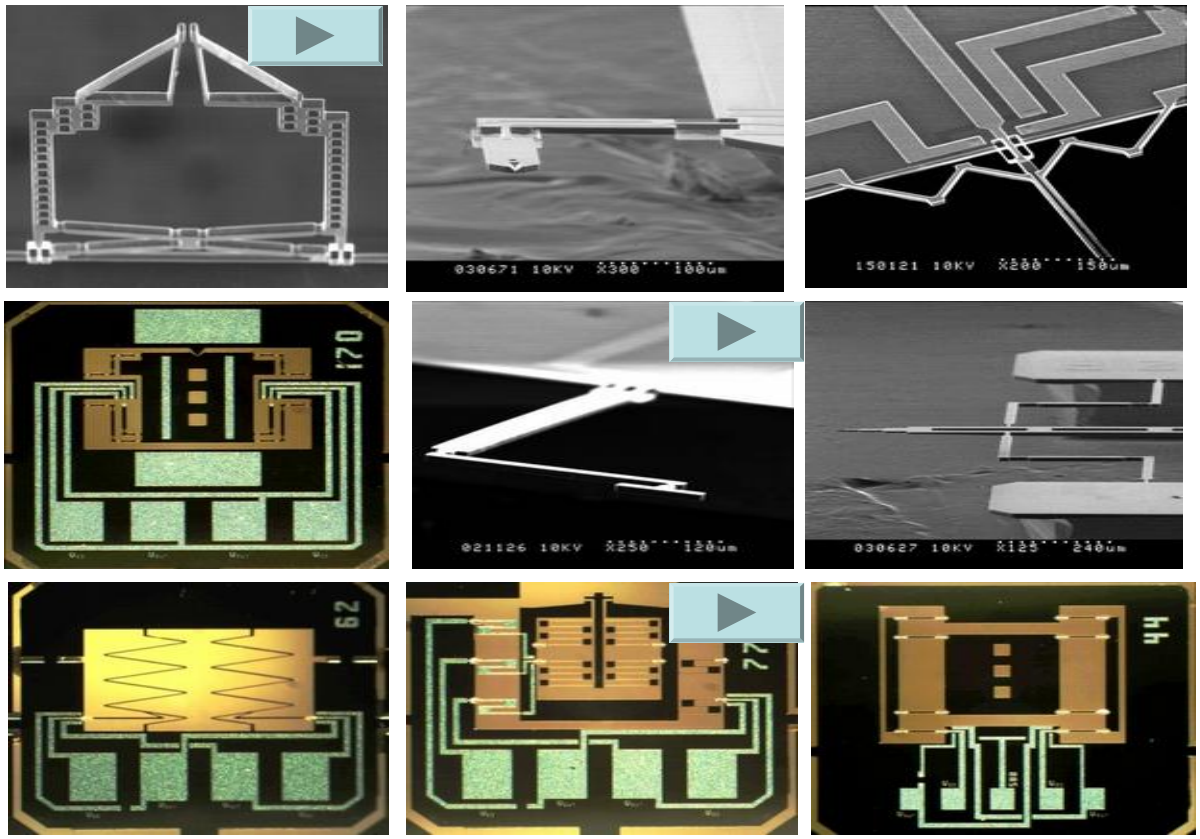
See seprate presentation

AMG TECHNOLOGY

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



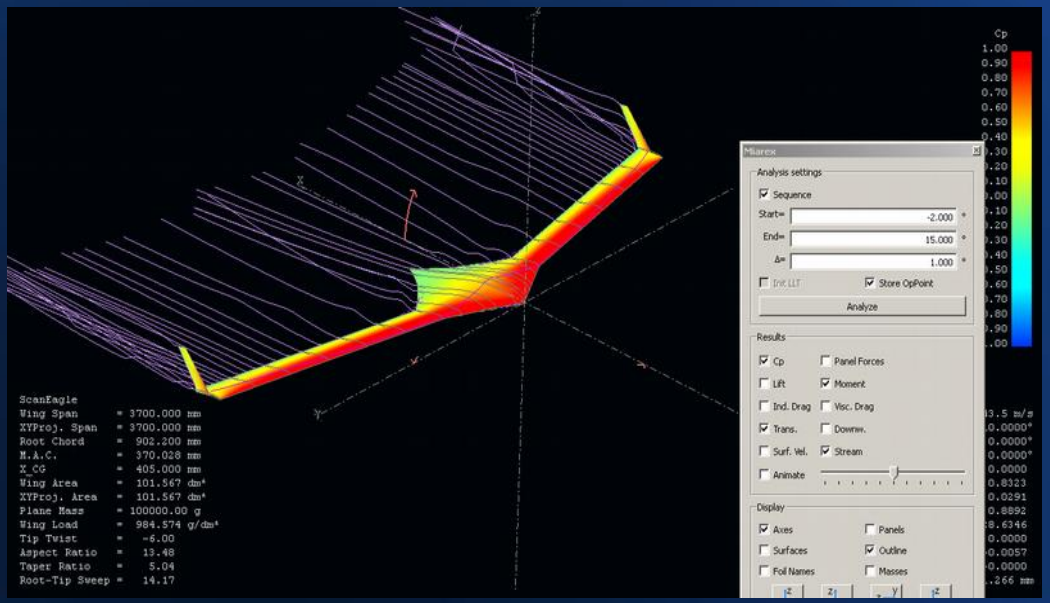




Acceco systems

O & K co. Acceco systems capabilities

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



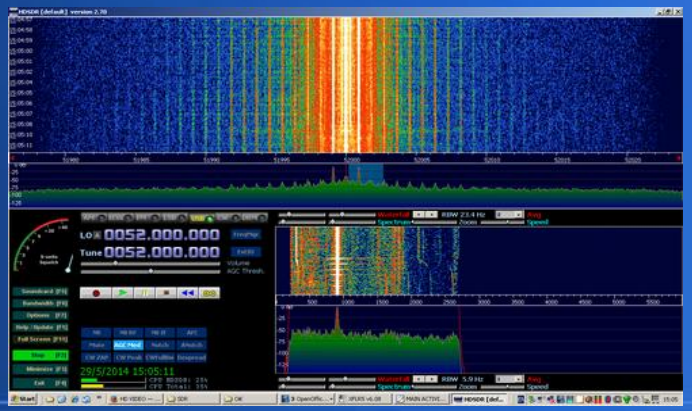
O & K co. Acceco systems capabilities

Sofia University cubesat project

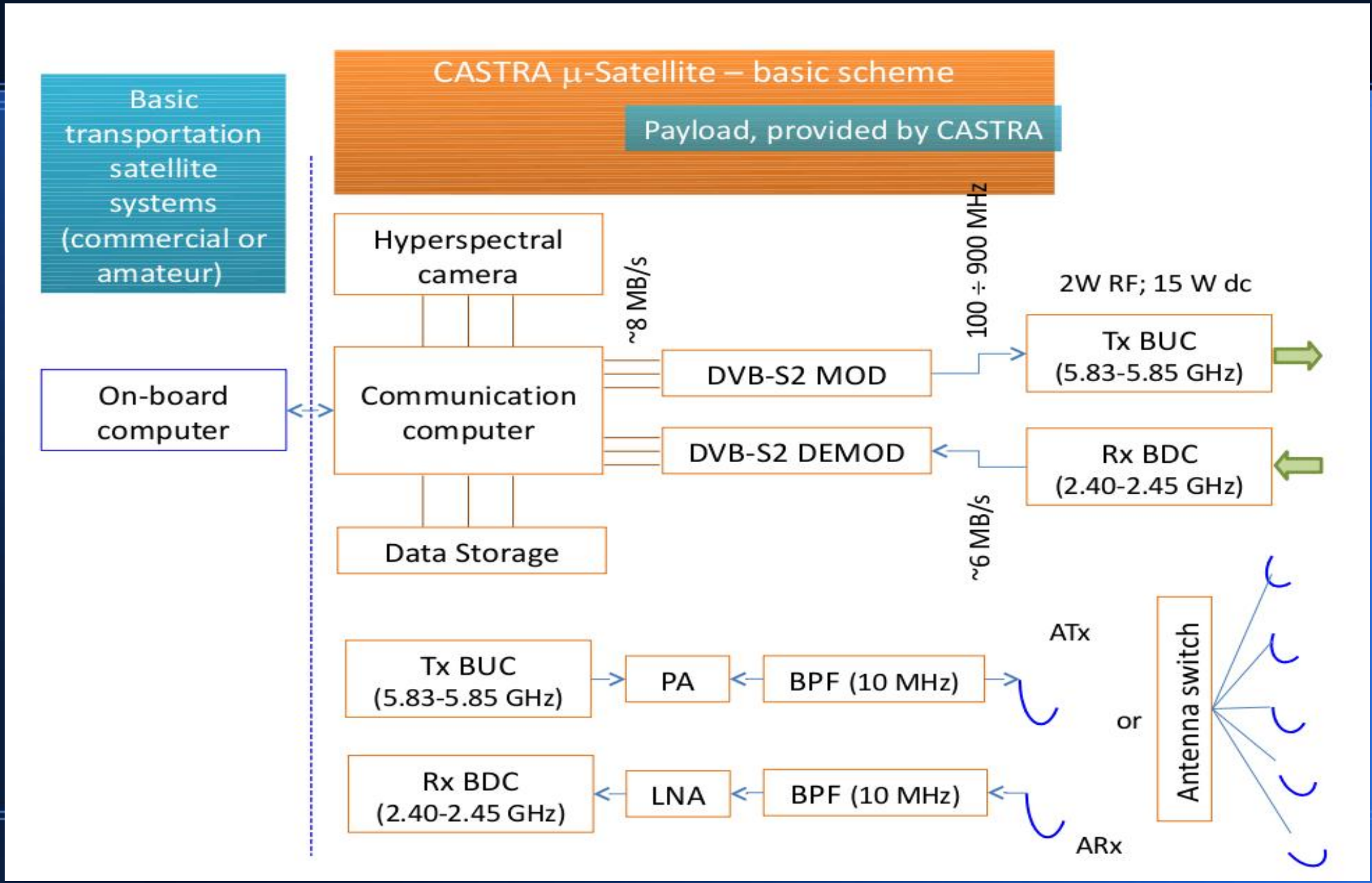
- **Microsat prototipe with folding solar panels**
- **Hi-res imaging/video camera & high speed down/up link /DVB-S2/**
- **Micro truster /hot gas/ for orbit transfer - safe,low pressure tank**

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.

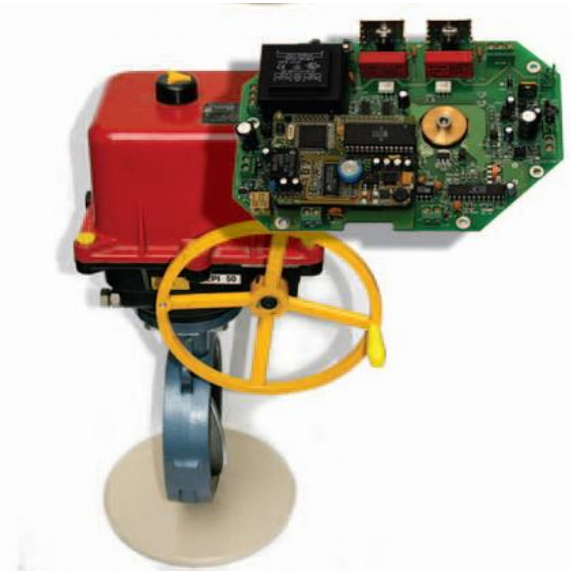
The Company has completed numerous automation projects across an array of industries, countries and clients.

Point L Intelligent Actuators' Control

Non-contact Position Readout and Control

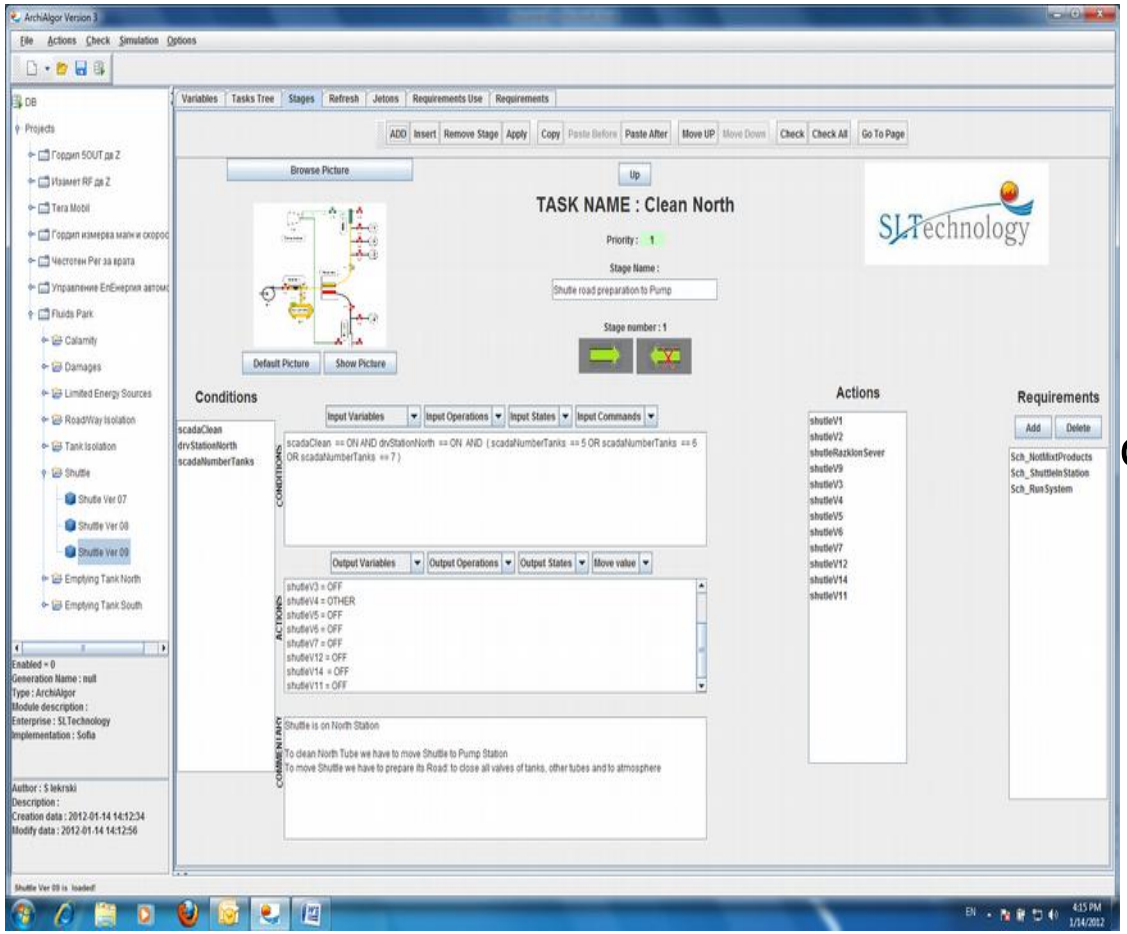
Functional diagnostics and control incorporated in actuator

Application range - all actuator types, new and used



Intelligent Input/Output Devices, Gateways

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

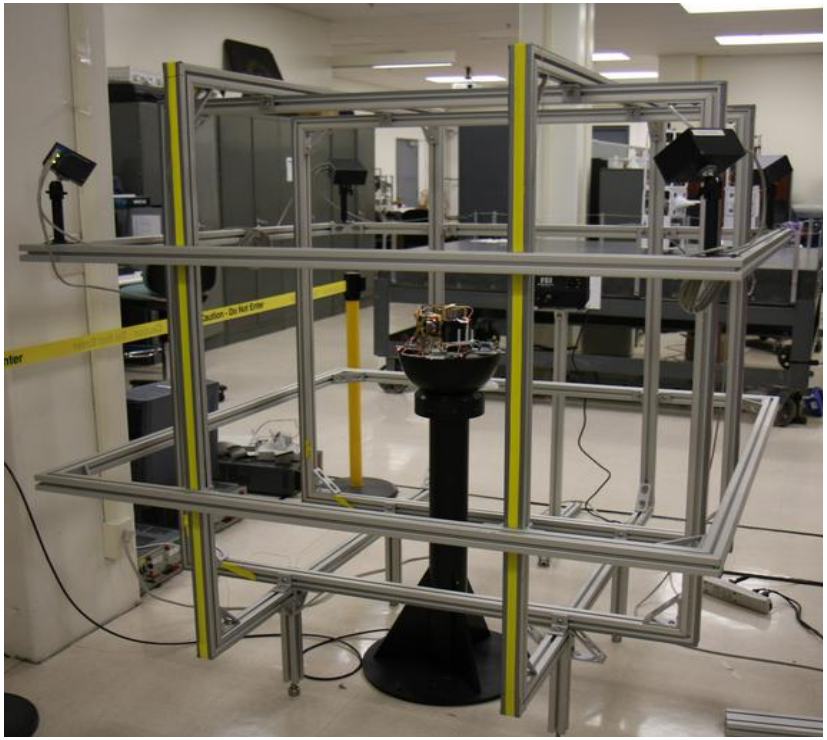


ArchiAlgor is based on an innovative **engineering approach**, enabling analysis, structured description and solution of critical control tasks

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 microsatellites' 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 microsatellites 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 shifter

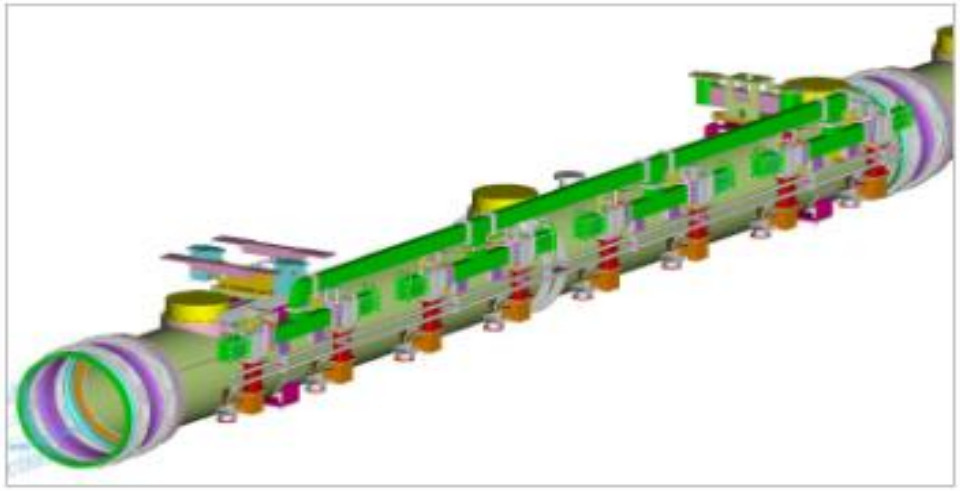
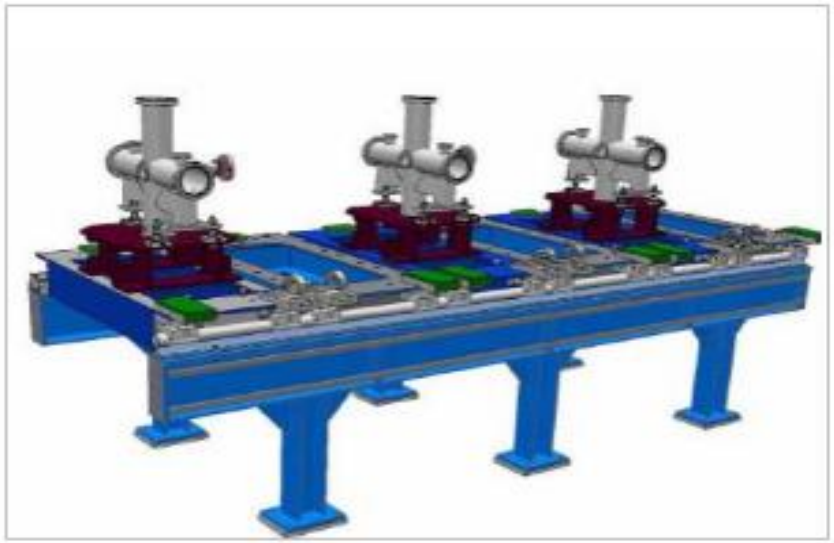
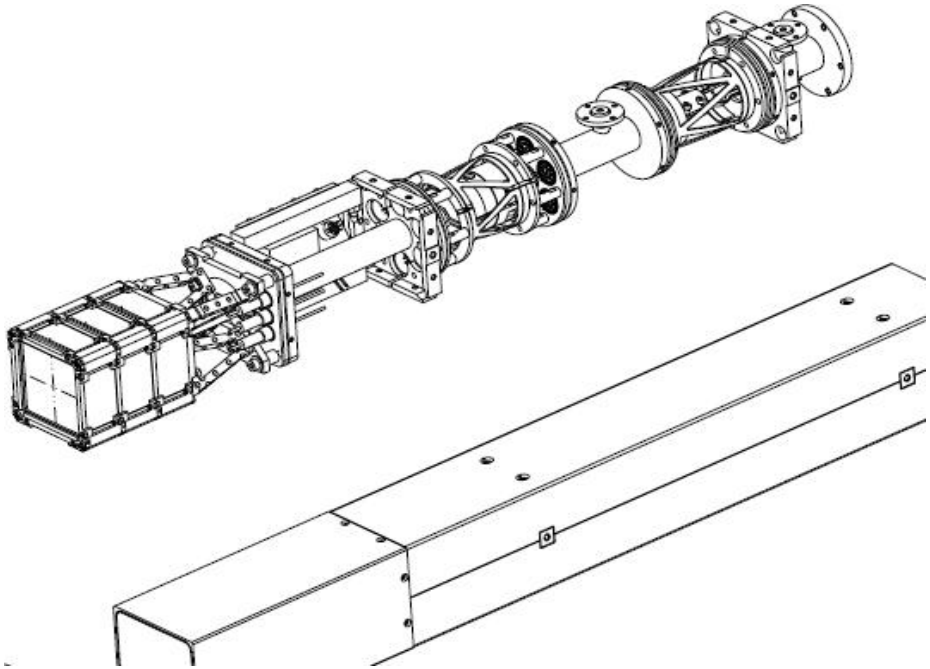


Fig. 1.2 Support system for waveguide distribution systems with kinematic type links

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

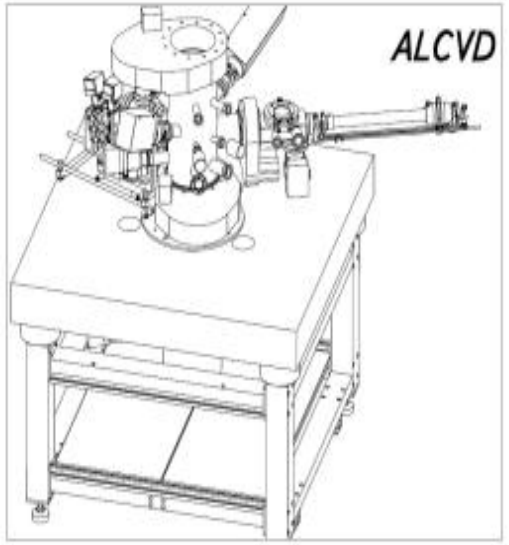


Fig.4.1 Experimental equipment for Atom Layers CVD

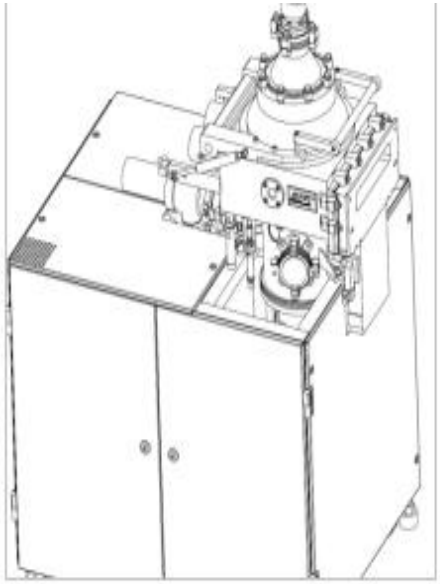


Fig.4.2 Experimental equipment for plasma etching

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

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

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

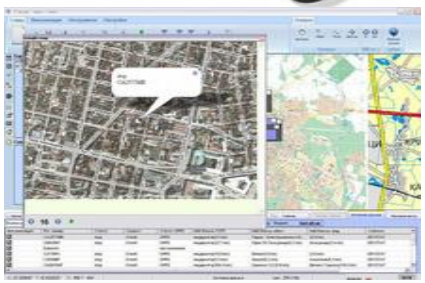
- Interrogator Units Supplier – EASD / Defense Electronics
- Producer
  EADS DS Belgium NV Oostkamp

ELECTRONINVEST

Navigation Systems design and applications in Automotive and aviation sectoirs;
Design and Manufacturing of electronic systems and precision sensor networks

ELECTRONINVEST

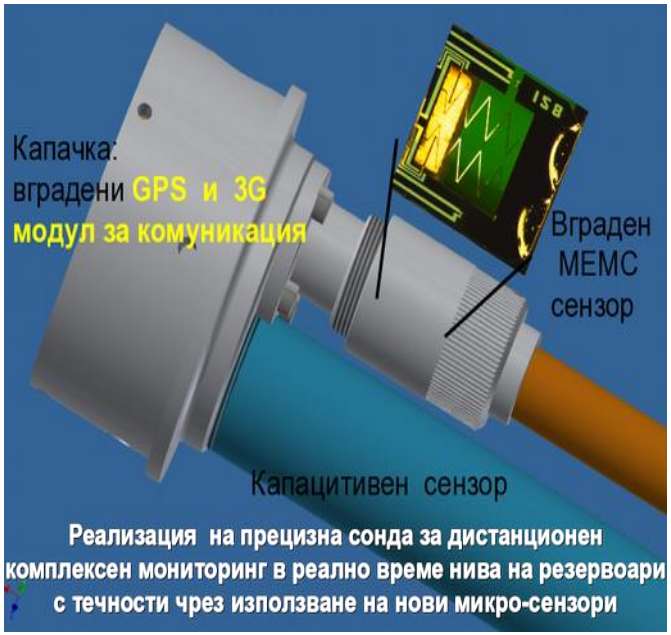
Dedicated GPS/Galileo/Glonass tracking solutions- R&D, development , manufacturing and operation of such networks



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

SIMEMSYS

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



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)

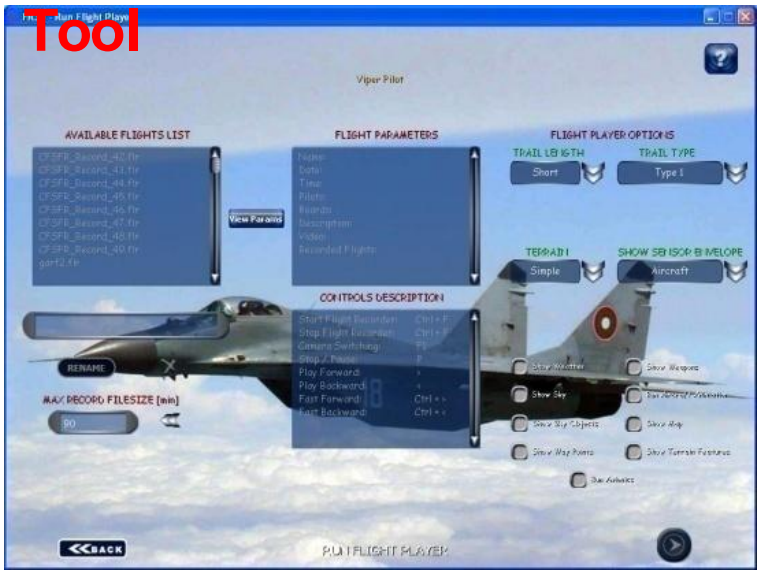
Ultra-compact embedded Linux controllers

SimSoft Ltd

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

SIMSOFT

FR3D – Flight Recorder Tool

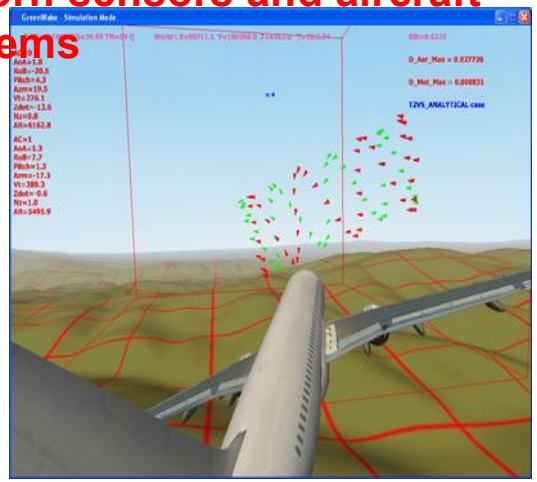


Tactical UAVs-frames

Example s

Control and management software for complex systems

real-time data processing and visulisation from airborn sensors and aircraft systems



Bulgarian Association for Modeling and Simulation

Cyber-security training and infrastructure

МТИТС 2011

MOD

National Revenue Agency 2014

Areas of expertise

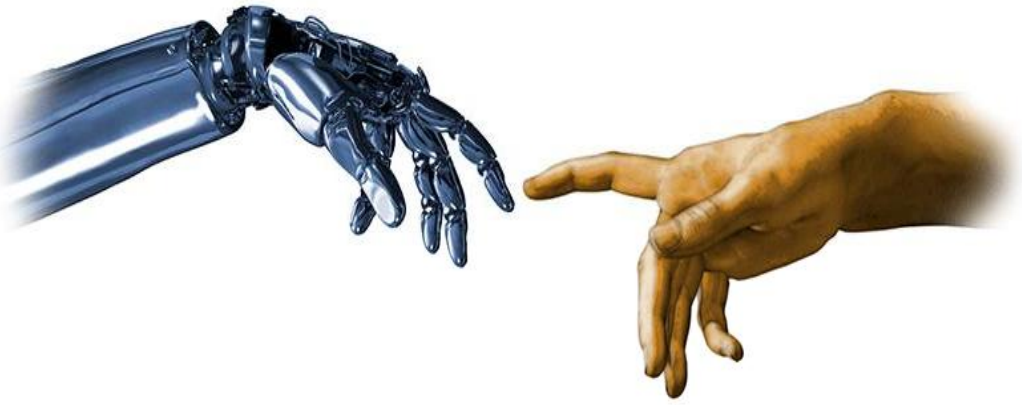
- **Software systems development for the needs of cyber-security and crisis management trainings**
- **Software tools in support of the decision making process in crisis management**
- **Application of tools and systems for modelling and simulation in the decision making process at operational and tactical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

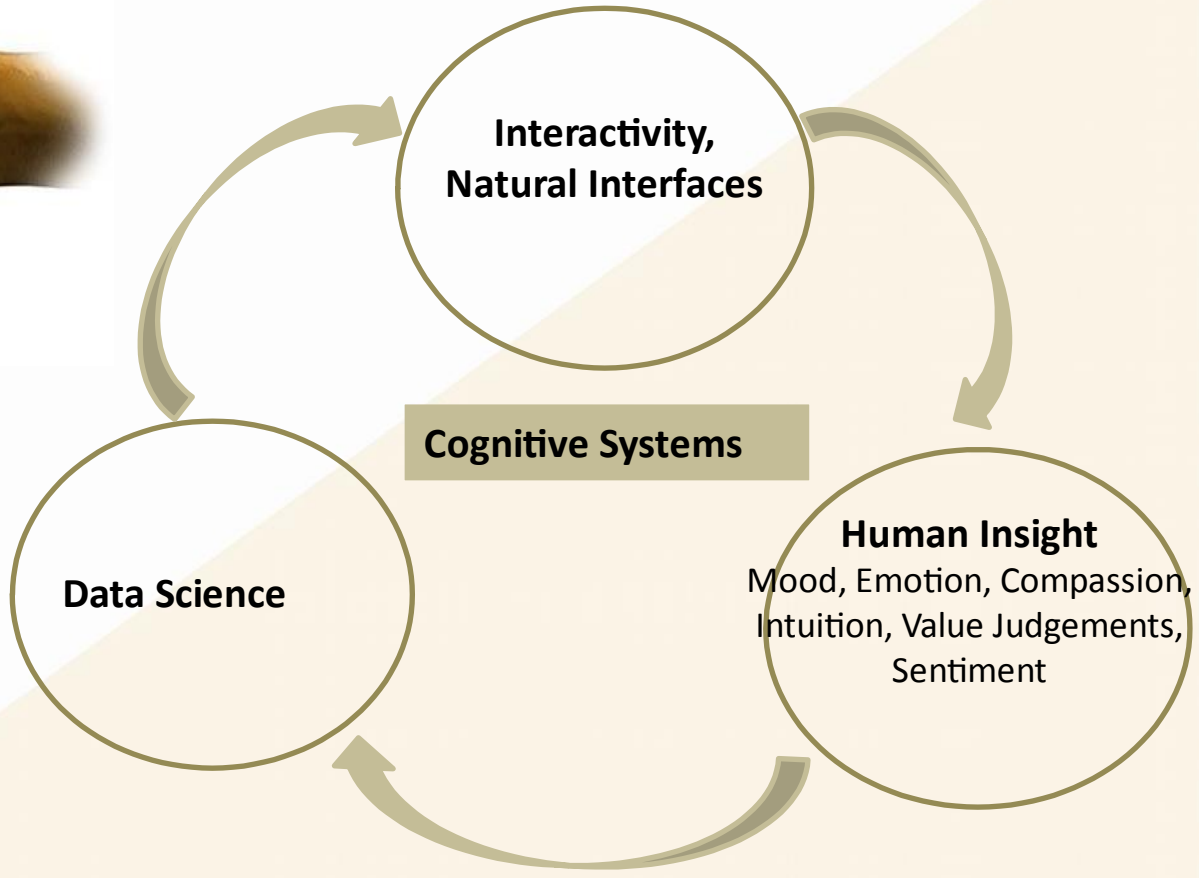
MOZAIKA Ltd.

Information Management for Aerospace

Mozaika - The Humanizing Technologies Lab

an SME and a Research Center





- **in operation since May 2013**
- **subject areas**
  - data science
  - natural interfaces
  - human insight
- **activity areas**
  - R&D and project development consulting for knowledge intense solutions
  - DaaS (Data as a Service)
  - Information/data infrastructures for a variety of applications
  - Natural human-computer interactivity
  - Voice biometrics
- **verticals**
  - Business Information, Human Resources Management, Earth Observation, Aerospace, Smart Cities, Cultural Heritage

At Mozaika we are trying to leverage data science with natural interfaces to provide solutions tailored to human behavior, attitudes and comprehension

Contact:
Mariana Damova, PhD
mariana.damova@mozajka.co
www.mozajka.co

Radio Engineering Department of the Physics Faculty, Sofia University

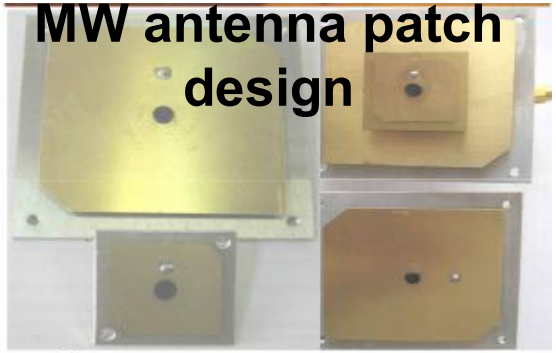
High-Speed Satellite communication systems and antennas;
RF plasma micro-thruster development

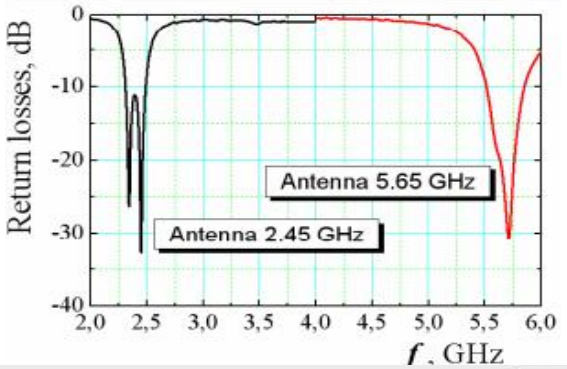
Design and manufacturing of low-profile satellite communication antennas

Sofia University
Department of Physics

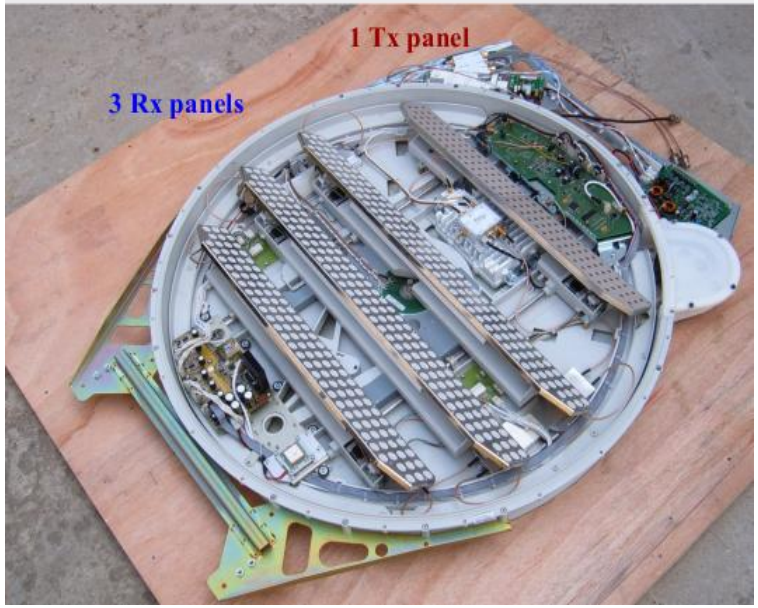
ANTENNA SYSTEMS
RaySat
Satcom on-the-move

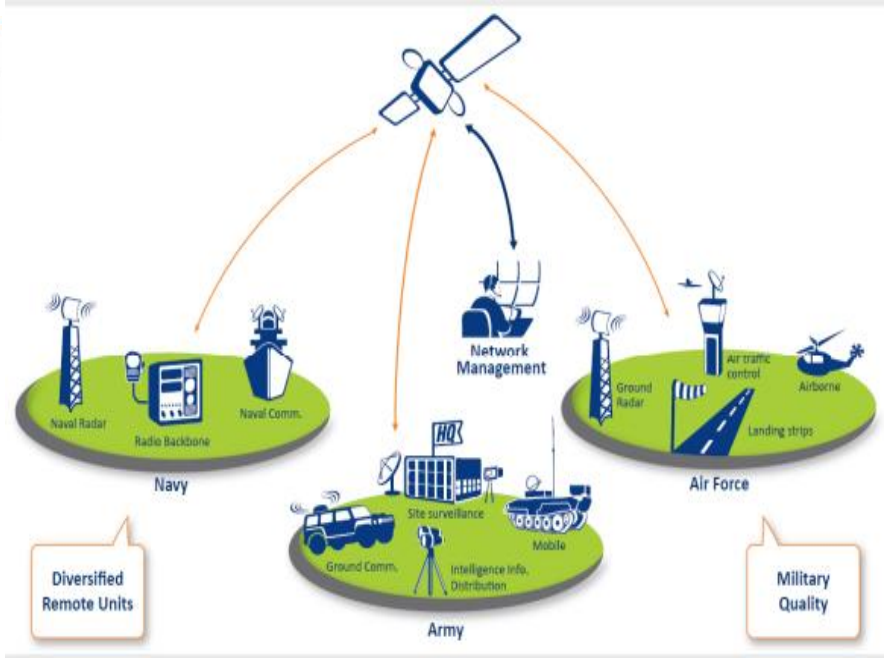
MW antenna patch design

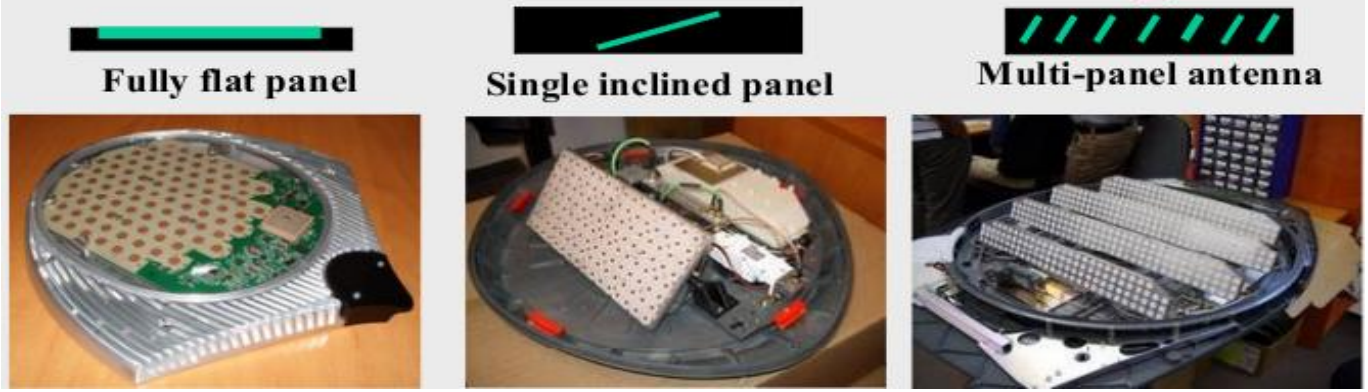




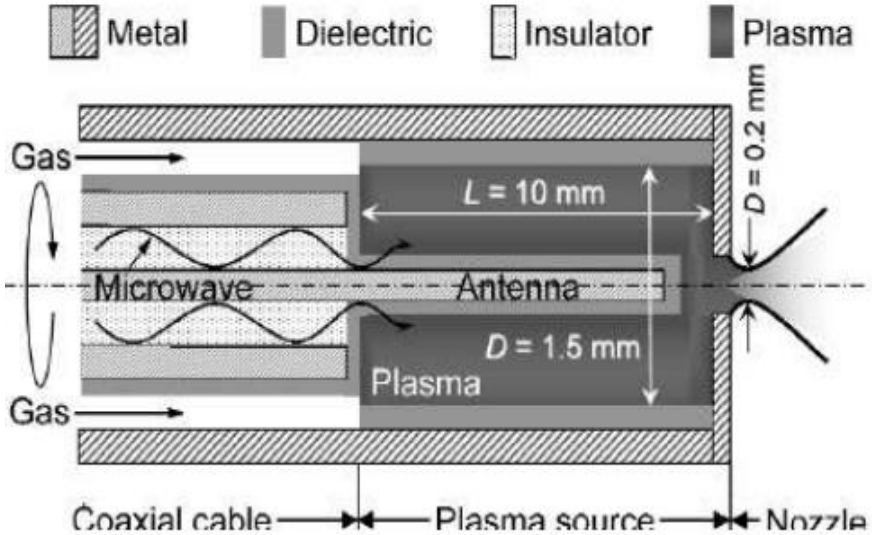
Example: multi-panel 2-way communication antenna (the so-called "mobile VSAT")

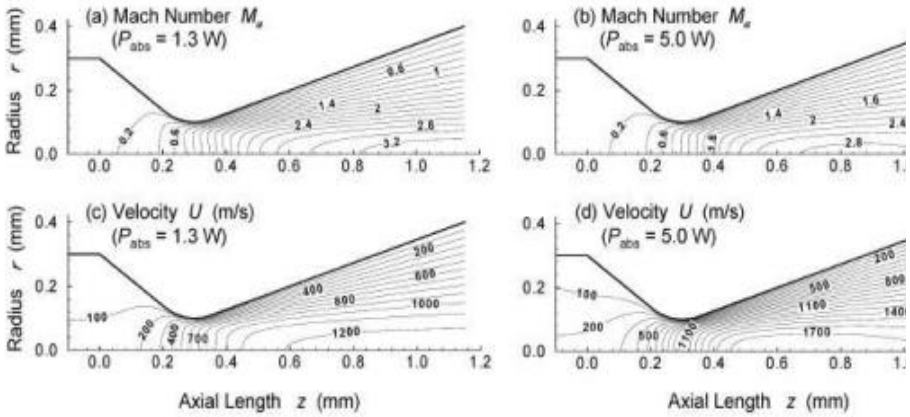






Microwave Plasma Micro-Propulsion System development at Sofia University





The developed Ar gas pulsed plasma source produces dense plasma with high gas temperature Tg ~1500-3000K.When used with a basic Laval-type nozzle, achieves maximum jet velocity estimated at v ~ 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 (~30 kg) with achieved Δv ~ 13-26m/s for 24-hour period. Dimentions 2cm X 0.3cm X 0.3cm, f=2.45GHz, ceramic tube, P<10W both in continuous and pulse regimes

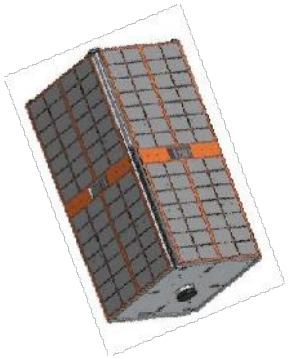
Assoc. Prof. J. Kiss'ovski, Sofia University

Content

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

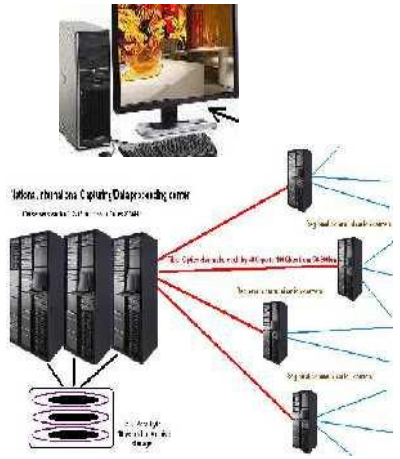
Main components of our satellite system

A satellite based ICT system



+

+



+

Minisatelite <1000 kg

➢ ***Microsatelite*** **<100 kg**

Nanosatelite <10 kg

Picosatelite <1kg

Ground station(s) and data 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

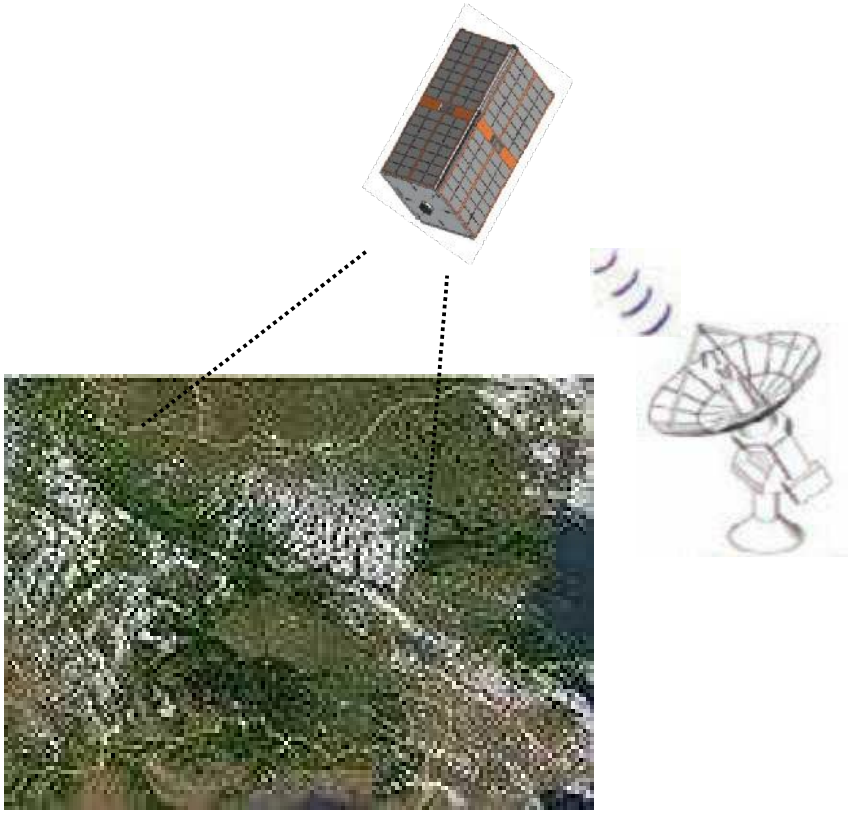
The development and integration of a functional system requires close cooperation and joint effort from organizations with complementary expertise

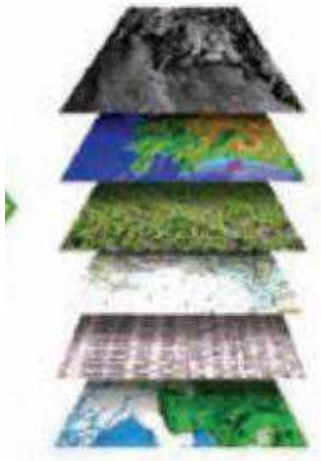
Main business applications of our system

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...





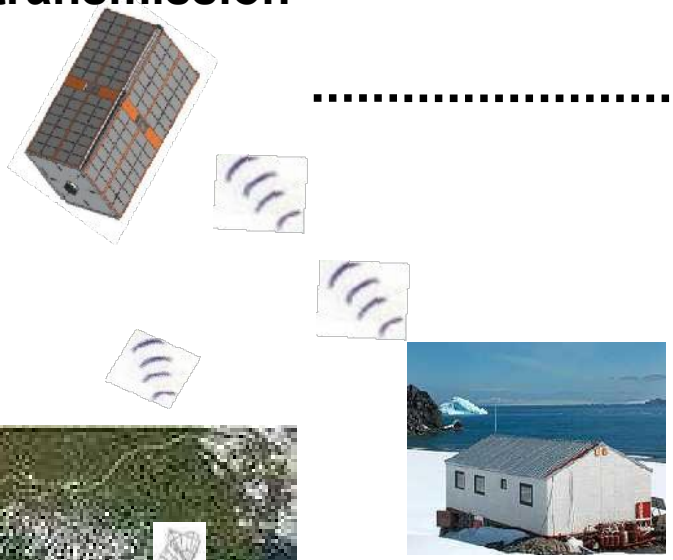
Remote sensing images and layers of data

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....

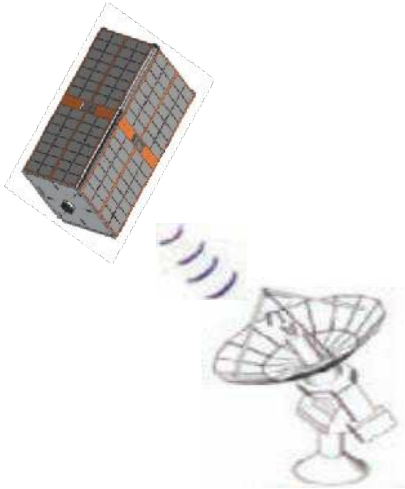
Position 1: **data collection and transmission**

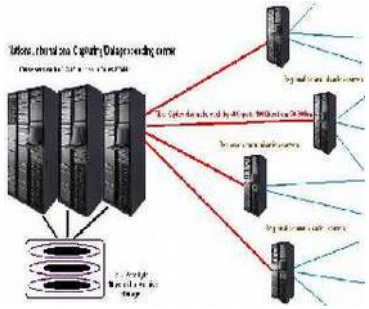


on-ground sensor networks

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

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



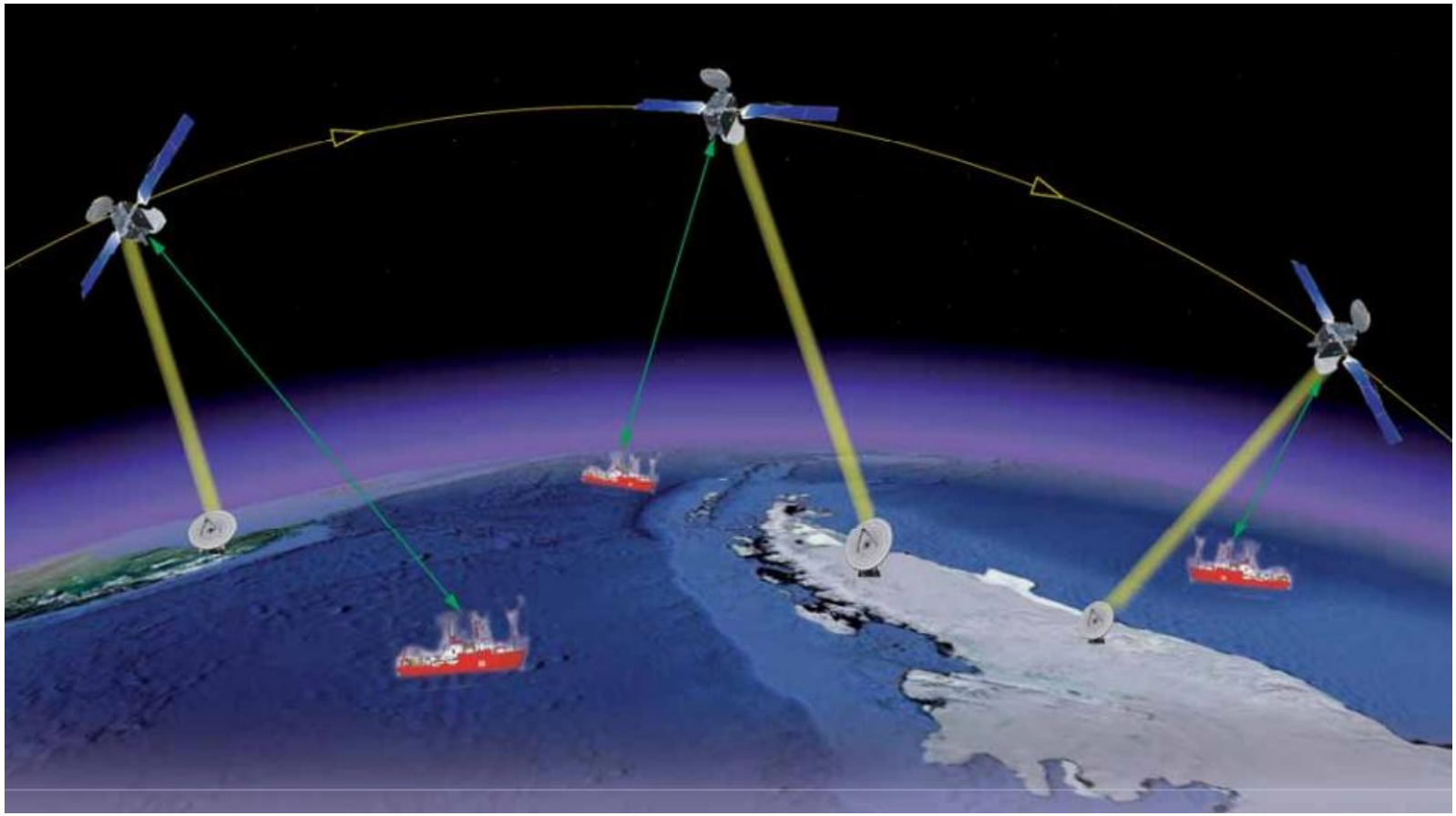


Receiving /control/ station

Main business applications of our system

Application №3:

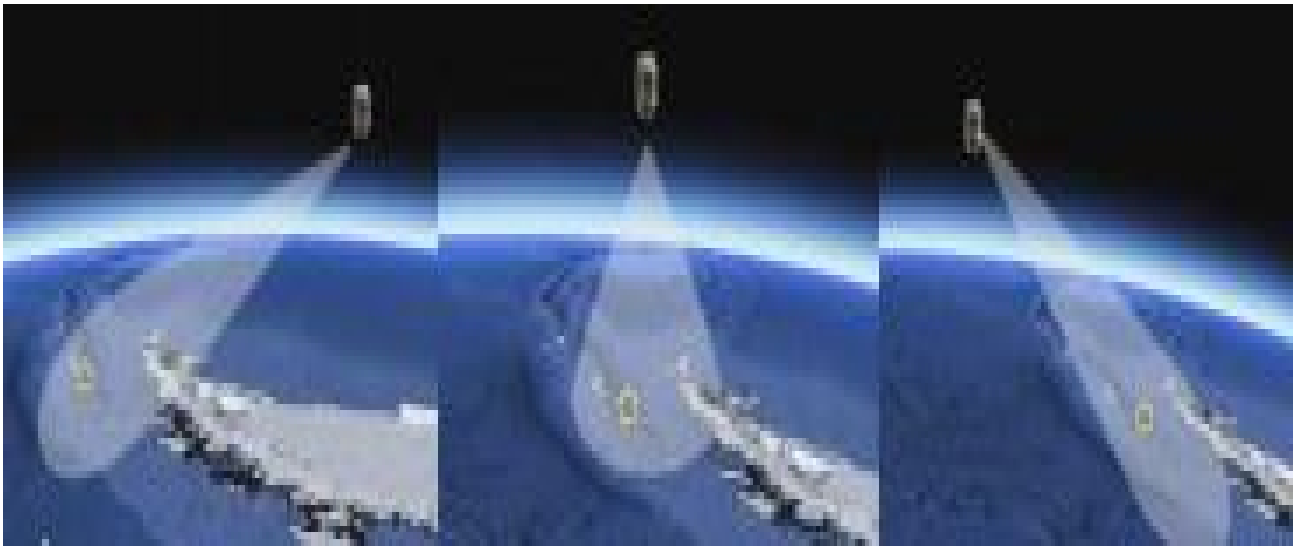
Land and Sea tracking of vehicles, humans, cargo, and other objects for the purpose of security, logistics, research etc ..

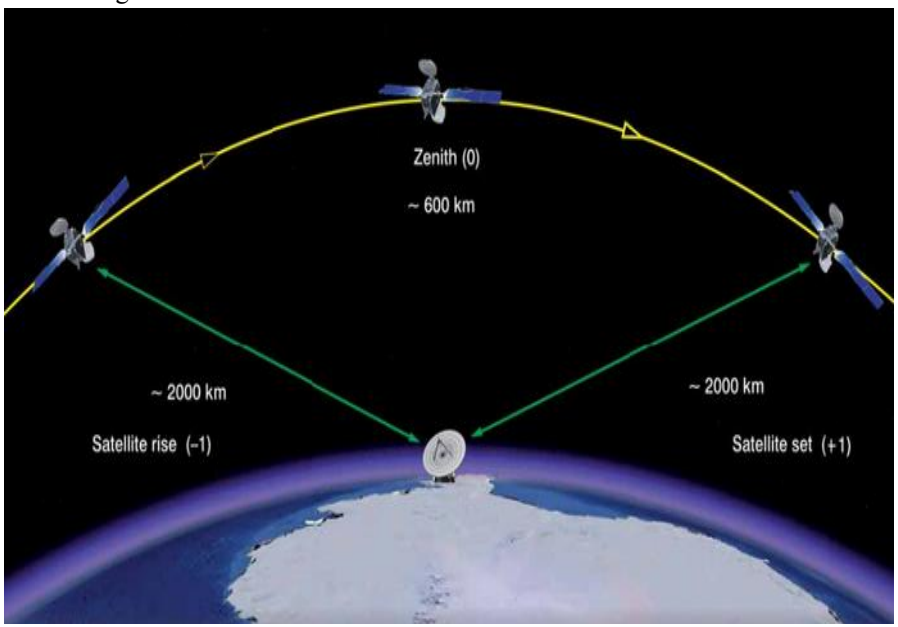


Additional Information

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





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. Total data volume for a single communication session is evaluated at ~100 MB for the uplink channel and ~300 MB for the downlink channel

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-satelliteUtilization
with the submission entitled:

SofiaUniversitySAT (Small Communication Satellite Mission for Enhancement of Antarctic Investigations)

On July 1st, 2012 in Tokyo, Japan.

Shinichi Nakasuka
General Chairperson,
The 2nd 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

UNISEC

The 2nd 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

