The Centre of Excellence for Space Sciences and Technologies
Inspiration and motivation for the younger generations throut space technology and innovation

1. Introduction

The Space has been one of the hidden success stories of European industry in recent years. It is also a sector where productivity is more than four times the national average - contributing the bigest summa per worker to European GDP –perhaps not surprisingly given the large capital investments and high skilled nature of the industry where nearly two-thirds of workers have degrees.

Science provides a very strong and vital part of our success in Space with the European being the second-largest publisher of major Space Science papers in the World, providing a knowledge base for many other developments. The technology spin-offs from Space affect industries from medicine to manufacturing. The end user applications affect our lives in every way, from communications at home and work to security, safety, entertainment and travel. The Space Industry covers not just spacecraft but also the manufacturing of the launchers and the ground equipment. Satellites perform many functions autonomously but need to be operated (supervised and controlled) from the ground. Satellites are also insured. These are termed Upstream industries. There is also the much larger Downstream market place. The downstream business sectors include the manufacture of mass market user equipment such as satellite TV dishes and set top boxes and devices for navigation and precision timing. Applications and software development using the in orbit infrastructure are of great importance in securing benefits from space.

Space has proven to be one of only a very few sectors where growth has remained resilient through the world-wide recession This has been possible because of the diverse range of customers for Space-enabled services from commercial telecommunications to institutional surveillance. As well as increasing market demand, this growth is built on strong European industrial capabilities in satellite manufacturing, operation, exploration sensing and in downstream applications. Space is perceived differently by different people. To some, Space is about astronauts and robotic craft exploring the universe. In fact Space covers a wide range of activities from commercial communications satellites, through location based services to Science and exploration. Any Space based infrastructure will support a myriad of applications and services. It seems, like ICT, to stimulate (through its disruptive influence) pervasive and continuing improvements in diverse sectors. All of these contribute to and benefit from the Space economy.

The goal of this proposal is to exclude the lack of scientists, engineers and technicians on the area of space research and development by dissemination of experiences in the space domain to contribute building of long-term partnerships between peoples from different Europe countries to run sustainable outreach activities which can act as catalysers, motivating pupils and students at different ages and education levels.

The Centre of Excellence for Space Sciences and Technologies (NCST-TUM), has been established by a consortium of Technical University of Moldova, academic institutions and some high-tech SMEs in order to take advantage of the benefits of space technologies and applications in Earth observation, meteorology and astrophysics. The RTD activities of NCST-TUM are focused on medium resolution interactive remote sensing and formation flying missions by involving in these projects a most of students at different ages and education levels. These goals are supported by the concurrent development of micro and nano satellite platforms an advanced ground control infrastructure and satellite integration facilities as well as a multidisciplinary laboratories for developing and testing of satellite systems and components in simulated space environments.

This Centre of Excellence for Space Sciences and Technologies provides the students, early career engineers and enthusiasts with educational resources on many aspects of Space Engineering. We actively work to increase usability of educational resources.

2. Center of Excellence for Spatial Technologies structure

The Center of Excellence for Spatial Technologies was originally created to promote this technology labs for students from many specialties from the Technical University of Moldova. Then it was done for other universities, colleges and schools as a center for the following structure:

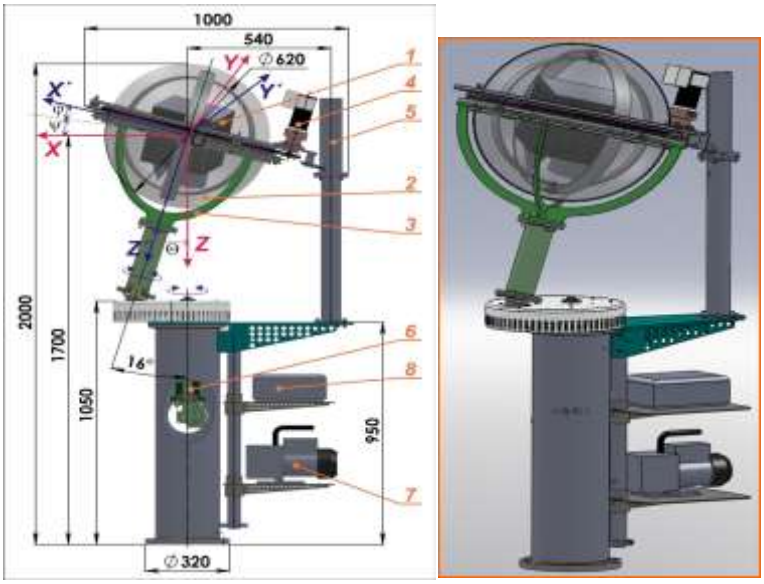
- Laboratory for satellite components development;
- Laboratory simulation and testing of the satellite attitude;
- The Center of Excellence Information Technologies and Communications;
- Laboratory for data processing and satellite images;
- Telemetry ground station communication satellites;
- Base Ground station for satellite images receiving;
- CELESTRON Telescope Astronomical Observatory.

2.1 Laboratory development of satellite components was the starting point that was founded to promote the concept of space technologies. Here the idea of creating a nanosatellite designed to arouse the enthusiasm of young people, to encourage them to get acquainted with the most advanced technologies in electronic communications space. Recent laboratory is well equipped with computers and equipment to the design and development of nano-microsatellite components such as electric power systems, on-board computers, data transmission equipment, systems, remote sensing (satellite image capture) as well as structural elements of satellites.

2.2 The laboratory simulation and testing of the satellite attitude is for students from many specialties physicists, mathematicians, electronics, mechanics, communication, computer, mechatronics to deal with a complex problem: the orientation, position, stabilize the satellite in space and attitude control of the satellite. For this purpose at UTM was designed and developed

The students design and assemble various satellite's components.

by teachers, engineers, PhDs, students headed by Academician Ion Bostan a simulator to investigate this complex issue. The simulator model capable of incorporating the satellite in a dome to create a vacuum and moves under the destabilizing mechanisms axes XYZ using the stand, and the micro-satellite must maintain the orientation of the axis projected in the X'Y'Z'. The stand consists of the following parts: model microsatellite; abode MS sanctuary housing installation MS mechanism rotation axis Z'; mechanism restricting MS rotation axis Z Actuator for changing attitudes MS axis XYZ; vacuum pump to create a vacuum in the dome, block order.



The general stand scheme for microsatellite attitude test .

To perform testing it needs to specially designed sanctuary (dome) microsatellite, which may create vacuum in the dome and has achieved cinematic to provide three degrees of freedom inside the sanctuary microsatellite. Testing processes are automated and operates in accordance with the method prescribed by the researcher, which gives the possibility of repeating the experiments and accumulating the necessary statistics to assess the quality of the attitude control.

The stand was visited by Vlad Filat, Prime Minister of Rep.Moldova and cosmonaut Vladimir Dejurov.

2.3 The laboratory data processing and imagery is aimed at familiarizing the students, PhD students with processing methods and application of these results in various fields.

Remote sensed images are generally obtained for different purposes. A peculiarity of images obtained from microsatellites is capture during the satellite's movement. This factor causes geometric distortions as well as radiometric ones. Their liquidation is being made at the phase of pre-processing of remote sensed images that is executed at ground stations. Usually, solar radiation reflected by the Earth's surface to satellite sensors is modified by its interaction with the atmosphere. The objective of applying an atmospheric correction, that is a part of radiometric distortion, is to determine true surface reflectance values and to retrieve physical parameters of the Earth's surface, including surface reflectance, by removing atmospheric effects from satellite images. Radiometric correction is arguably the most important part of the processing of satellite remotely sensed data. Such a correction is especially important in cases where multi-temporal images are to be compared and analyzed. Each image acquisition system produces unique geometric distortions in its raw images and consequently the geometry of these images does not correspond to the terrain or to a specific map projection of end-users.

Consequently, data integration requires geometric processing adapted to the nature and characteristics of the data in order to keep the best information from each image in the composite ortho-rectified products.

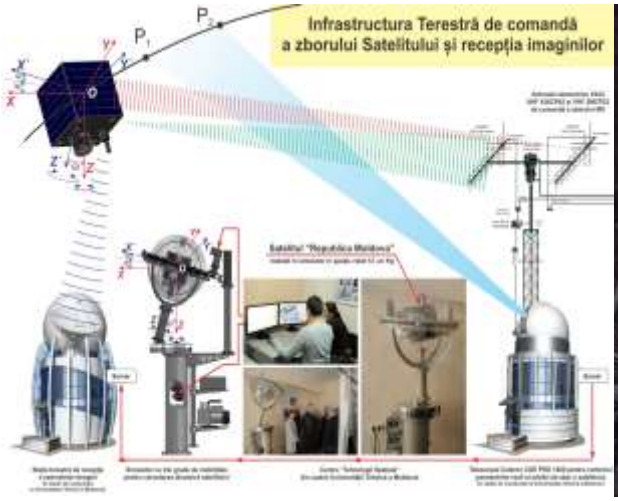
The laboratory of satellite data processing deals with the research on methods of pre-processing of distorted images obtained from microsatellites. There were analyzed and processed concrete examples of images for each type of distortion in software environment based on the methods of processing remote sensed images in spatial domain processing as well as in frequency domain processing and compares its efficiency.

Monitoring of environmental pollution and floods require satellite image processing

The remote sensing is a critical factor in Earth surface exploration and collection of scientific data. On a national level, it finds itself in such fields as: agriculture, forestry applications, hydrological applications, weather and others. Agriculture plays a dominant role in the economy of Republic of Moldova and assessments of the health of a crop, as well as early detection of crop infestations, is critical in ensuring good agricultural productivity. Remote sensing brings together a multitude of tools to better analyze the scope and scale of the deforestation problem that is also an important issue of our country. Examples of hydrological applications of remote sensing include wetlands mapping and monitoring, irrigation scheduling, flood mapping and monitoring and so one. In order to meet these needs, image processing procedures would make it easier then ever to read, explore, prepare, analyze and share information from imagery. Image pre-processing is the first level of procedures used to correct an image for data errors, noise, and geometric distortions introduced during the scanning, recording, and playback operations.

2.4 <u>The ground stations</u> for satellite images receiving and telemetry represents the communication infrastructure of NCST-TUM. This infrastructure is located in the TUM technique museum park, which enables students to familiarize all specialties TUM. It have developed two distinct nodes : the communication telemetry located in with antennas on the roof of the TUM building, and the second node – the ground station for receiving of satellite digital images is located in a building with a special architecture . This infrastructure, although it is part of SATUM project achievements, it is widely used for promoting space technology. The development and design of communication ground stations it was attended a large number of students for developing theses, master's degree, including PhD students, also it are used to perform practical work and laboratory for smart grid radio communications, satellite communications related disciplines.

A significant result is that the software was developed for ground control stations and the parabolic and telemetry antennas and graphical interface position monitoring satellites.



Ground infrastucture for satellite tracking.
(https://www.google.com/maps/place/Parcul+UTM/@47.0604807,28.8695115,17z/data=!3m1!4b1!4m2!3m1!1s0x40c97ce04317dd6f:0x9a3825922d437d80)


The ground station building and the software interface for satellites tracking.

2.5 <u>The Excellence Center of Information Technologies and Communications</u> was done as a promising infrastructure for hosting a strong knot cloud computing computer network, research laboratories, simulation and design of various information systems, communications, including satellite data processing, calculations aerodynamics, etc. Everything in this place is a multi-purpose hall for achieving the various, inter-university and international academic meetings. This Center will take place lectures, practical work not only TUM teachers, but will predominate invited teachers to promote the most advanced information and communication technologies. A successful collaboration are workshops carried out by IBM Romania, which under the Academic Initiative IBM, teachers and students are

familiar with new technology design type Model Driven Systems Development with IBM Rational Rhapsody, ILOG OPL - Operations Research, mathematical optimization, mathematical programming, Mathematical Programming (MP) and Constraint Programming (CP), etc., in the future research and projections are planned with the effective participation of students in projects GNSS/LPS based Online Control and Alarm System (GOCA) on base of Mathematical Models and Technical Realization of a Scaleable System for Natural and Geotechnical Monitoring Analysis, Numerical modeling in CFD framework with CFD applications in renewable energy conversion systems design, aerodynamics, CFD applications for structure strength, etc.

Another aspect of perspective is hosting an online learning platform Moodle to create online multilingual various courses on space technology issues, from popular courses for students and ending design management courses satellites (http://elearning.utm.md/moodle). It will facilitate attracting a large number of young people from an area spread in Eastern Europe, and possibly wider.

2.6 Astronomical Observatory with CELESTRON Telescope.

In order to extend the possibilities of space technology promoting the Astronomical Observatory was decided to build as the ground infrastructure component of the Space Technologies Center of Excellence. With the financial support of the Ministry of Education, there was purchased the Astronomic Observatory with remote computer control, based on the telescope of Celestron C14 Edge HD model with CGE-PRO mount, which will be mounted in a specially constructed building located in the Technology Museum Park and connected to the Space Technology Centre, which enables to track the moon, the sun, practically all the planets, various constellations, including objects in low orbit of the Earth, such as the International Space Station orbit LEO satellites, aircraft, and others.

The telescope CGEM DX 1400 HD combines Celestron's newly designed CGEM DX Computerized Equatorial mount with its new EdgeHD optical system. With more than 60% more light gathering power than the 11" telescope, the CGEM DX 1400 is Celestron’s largest optical system in its class. Featuring our premium StarBright XLT coatings and 14" of aperture, this telescope gives the brightest, clearest views whether observing planetary or deep-sky objects. The CGEM DX™ mount is the newest member of fully computerized Equatorial mount series capable of carrying Celestron’s high-end 11" and 14" optical tubes. The CGE PRO style, tripod holds even our 14" optics securely while dampening vibration, which is ideal for both imaging and visual observing. It is capable of holding 50 lbs of payload and slewing at 5° per second, it

Astronomical Observatory with CELESTRON Telescope

is able to instantly point to any of the celestial objects in the database. Equatorial mounts are recognized for their rock solid stability, simple balancing and easy accessibility for attaching accessories. With sophisticated software features like the Hibernate function, the CGEM DX can maintain its star alignment night after night without needing to be re-aligned, making it an excellent choice for a permanent observatory facility. The CGEM DX series has a new innovative Polar alignment procedure called All-Star™. All-Star allows to choose any bright star, while the software calculates and assists with polar alignment. Another great feature of the CGEM DX is the Permanent Periodic Error Correction (PEC) which will allow users to train out the worm gears periodic errors, while the mount retains the PEC recordings. For objects near the Meridian (imaginary line passing from North to South), the CGEM DX will track well past the Meridian for uninterrupted imaging through the most ideal part of the sky. The CGEM mount has a robust database with over 40,000 objects, 100 user defined programmable objects and enhanced information on over 200 objects.

The telescope and its infrastructure will be used for educational purposes for the study of planets, sun, moon and other constellations, including astral phenomena and Earth bodies (satellites). Recently, there has been performed some work on the connection of the Astronomic Observatory and Earth Station with the Space Technology Center, a complex that will facilitate more efficient observation and identification of the astral phenomena and Earth space bodies (satellites).

3 Space technology research and development projects

There are some innovation and education projects and activities of the NCST during the last years directly related to providing of space technologies.

1. Development of operational system and research of satellites dynamics and attitude in space conditions. 2011-2012 (11.838.06.01A) ME, Technical University of Moldova, acad. Bostan Ion.
2. Development of the earths surface image capturing system for the microsatellite. (11.838.06.07A). 2011-2012 TUM, acad. Bostan Ion., Institute of electronics engineering and "Dumitru Ghiţu", ASM, acad. Canţer Valeriu.
3. Research of the microsatellites attitude control methods and procedures for capturing processing and real time image transmission. (11.838.06.04A). 2011-2012 ME, Technical University of Moldova, dr. Secrieru Nicolae.
4. Orientation and stabilization methods on capturing images from long distances associated with real time coding, compression, protection and transmission. (10.820.08.08GA). 2010, ME, Technical University of Moldova, dr. Secrieru Nicolae, University Siegen, Germany, prof. Christoph Ruland.
5. Equipment for microsatellites stabilization, orientation and attitude control for image geometric distortion of the captured images for research and education. (12.220.15.08A). 2012, ME, Technical University of Moldova, Acad. Bostan Ion.
6. Ground stations and microsatellite communication, capturing images transmission methods and procedures research. (13.827.16.03A , 2013-2014), ME, Technical University of Moldova, dr. Secrieru Nicolae.
7. Creating Digital Network Universities In Applied Science Themes And Economics In Moldova (CRUNT). 2011-2014, (516597-TEMPUS-1-2011-1-FR). ME, Technical University of Moldova, Acad. Bostan Ion.

Details:
http://www.date.gov.md/ckan/ro/dataset?q=lista+program+de+stat&sort=score+desc%2C+metadata_modified+desc)

4 International cooperation.

In order to give a more extensive process of promoting space technology, NBTC has established relationships with several international centers such as the Faculty of Aerospace Engineering at the Polytechnic of Bucharest (Romania); Space Agency of Romania (ROSA); University of Siegen (Germany); Karlsrue University of Applied Sciences (Germany); University of Darmstat (Germany), etc. The idea is to invite scholars from these institutions for lectures, conferences, symposia, seminars, workshops etc.. to familiarize doctoral students, students, including teachers with the latest developments in such technologies. During the year 2010-2013 were conducted several international events:

1. ICTE 2010 - International Conference Telecommunication, Electronics, Informatics, (20-22 May), which have made reports and presentations of the results obtained in the section "Spatial Technologies" attended by many personalities from Germany, Greece, Slovenia, Romania, Russia and Ukraine .

2. Workshop in UTM with partners at the University of Siegen (23 to 25 May 2010). In this workshop they discussed issues of capturing images using microsatellites. Teachers participated in the German Christoph Ruland and Sergey Tkachuk, the UTM: staff CPAE, Telecommunications and Computer departments, doctoral and master.


3. United Nations Basic Space Technology Initiative - 2010 Symposium (21-23.09.2010). In the symposium United Nations Basic Space Technology Initiative - 2010 Symposium (21-23.09.2010) at Gratz, Austria participated the NBTC collaborators, the lecturers V. Blaja and Gh. Bodean.
4. In the PhD Summer School, organized by NASA in Iasi, Romania (7-16.07.2010). During the meeting they discussed issues related to robotic systems and space control. Participants from UTM made a series of reports: Ion Zarea "Modeling the dynamics of microsatellite in orbit"; Sergiu Gangan and Vadim Popa "Algorithms and microsatellite attitude control programs"; Eugen Suman "control algorithms and interaction of subsystems microsatellite" Constantin Cazacu "collection and preliminary processing of images microsatellite".


Participation of the TUM young collaborators on workshops

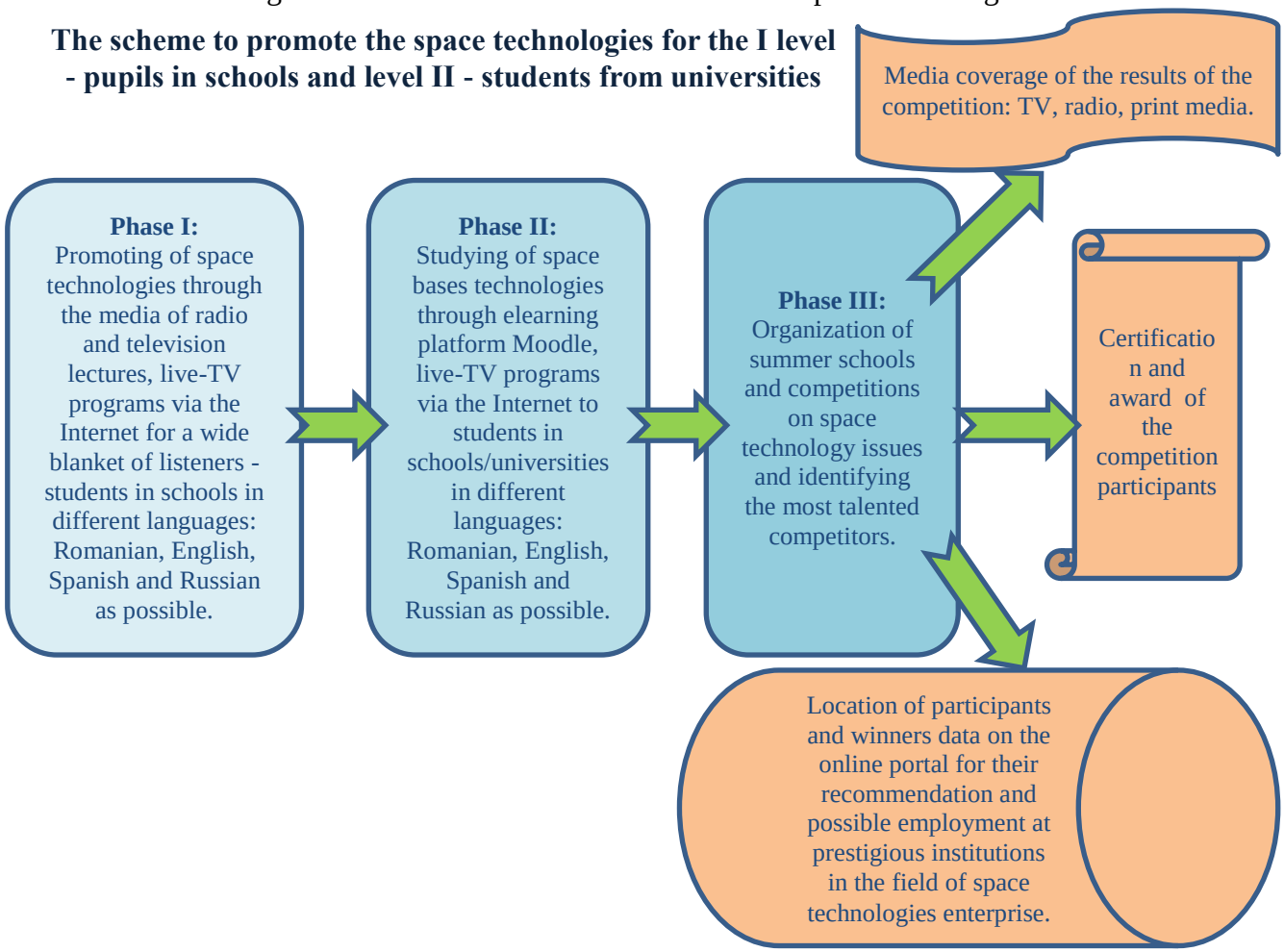
5. The Workshops at the University Siegen with the participation of the TUM collaborators (23-26.11/6-7.12.2010). In these workshops were discussed communication problems with microsatellites, coding, encryption of images captured by microsatellite and results in project collaboration UTM-University of Siegen. Our partners in Siegen reports emphasized the encryption methods and encryption public key information, and the TUM collaborators has made a series of reports: Gh Bodean "Coding and data encryption stochastic methods"; Olga Ghincul, N.Secrieru "Research on pre-processing algorithms of images captured by satellites"; Anatol Sochireanu, Ion Bostan, N.Secrieru "Guidance and Stabilization System of the microsatellite"**.**

5 Educational activities and promoting space technology.

The goal of NCST is to exclude the lack of scientists, engineers and technicians on the area of space research and development by dissemination of experiences in the space domain in Republic of Moldova and to contribute building of long-term partnerships between peoples from different Europe countries it is planned some activities which can act as catalysers, motivating pupils and students at different ages and education levels:

- Lessons for students popularization and promotion of space technologies;
- Annual Conferences, Symposiums ;
- Exhibition of student achievement and annual The competition "Open Universe";
- Competitions with international participation in electronic systems and mechatronics and micro- robotics;
- Summer schools with international participation in space issues;
- Courses for students and master of space technologies;
- Designing the Diploma Bachelor and Master theses;
- Teaching online astronomy lessons with Celestron type telescope Astronomical Observatory;
- Promotion of space technology and space phenomena based portal with Celestron type telescope Astronomical Observatory;
- Creating online courses for students and master of space technologies.

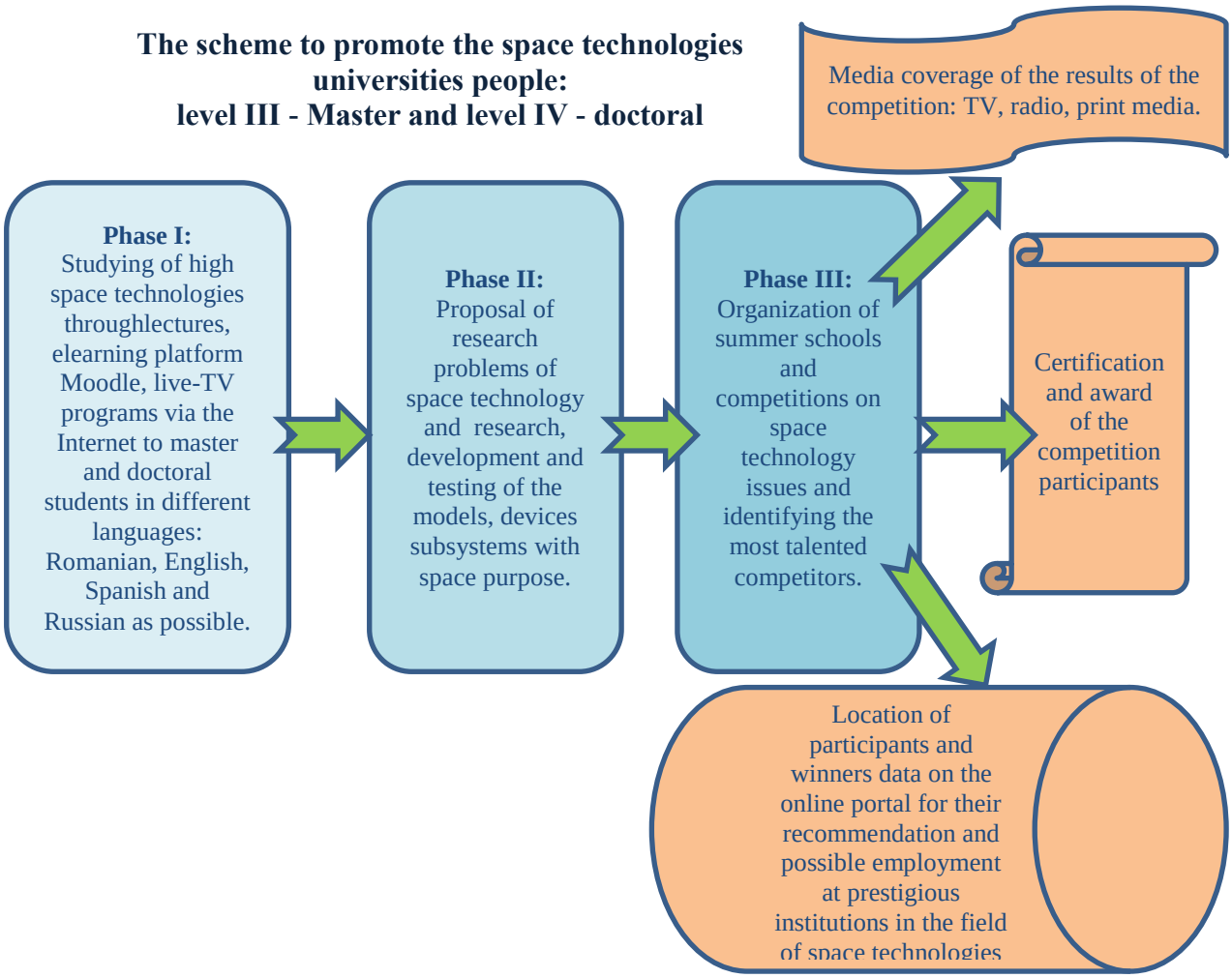
The scheme to promote the space technologies for the I level - pupils in schools and level II - students from universities



We plan to achieve these activities on stage and special schemes for different levels of students, master and PhD. For levels I and II, students from schools and students propose the following scheme, which provides for three phases for each year:

Phase I: Promoting of space technologies through the media of radio and television lectures, live-TV programs via the Internet for a wide blanket of listeners - students in schools in different languages: Romanian, English, Spanish and Russian as possible.

Phase II: Studying of space bases technologies through elearning platform Moodle, live-TV programs via the Internet to students in schools/universities in different languages: Romanian, English, Spanish and Russian as possible.
Phase III: Organization of summer schools and competitions on space technology issues and identifying the most talented competitors.
Ciclul se finalizează cu reflectarea în mas-media cât petrecerea concursului, atât și premierea participanților. Un moment important constituie crearea unei ”baze de date” a participanților cu recomandări pentru încadrarea lor la instituții prestigioase sau/și angajarea la firme din domeniul tehnologiilor spațiale.



Pentru nivele III și IV – masteranzi și doctoranzi propunem în mod similar următoarea schemă, care prevede trei faze pentru fiecare an:

Phase I: Studying of high space technologies throughlectures, elearning platform Moodle, live-TV programs via the Internet to master and doctoral students in different languages: Romanian, English, Spanish and Russian as possible.

Phase II: Proposal of research problems of space technology and research, development and testing of the models, devices subsystems with space purpose.

Phase III: Organization of summer schools and competitions on space technology issues and identifying the most talented competitors.

Training cycle ends with a media coverage as party competition and awarding participants. An important point is to create a "database" of participants with recommendations for their admission at prestigious institutions and/or companies engaged in space research and technology development.

Panoramic view of ground station infrastructure

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