

Клъстер АЕРО-КОСМИЧЕСКИ ТЕХНОЛОГИИ, ИЗСЛЕДВАНИЯ И ПРИЛОЖЕНИЯ

~~Cluster AERO-SPACE TECHNOLOGIES, RESEARCH AND APPLICATIONS~~

Small satellite based ICT system for providing customer specific products and services based on remote monitoring of environment and high-speed satellite data communication applications

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8/12/2014

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www.castra.org

- **General information about the cluster**
- Remote sensing and business opportunities
- Main components and business applications of CASTRA's spaceborn ICT system
- Project structure, duration and cost

Cluster AEROSPACE TECHNOLOGIES, RESEARCH AND APPLICATIONS (CASTRA) is an industry driven non-government organization of SME's and Academic institutions, developing technologies, products and services in the aerospace domain and its applications.

CASTRA's vision is to act as a strong professional organization in the field of aerospace technologies, research and applications to the benefit of society.

CASTRA's mission is to drive the research, innovations, technology and business applications developments in the aero-space sector, to inspire and motivate the public, Academic and SME interests and activities in it, and to support the organizations - members of the cluster.

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**
- **Green Embedded Systems**

13

➤ 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

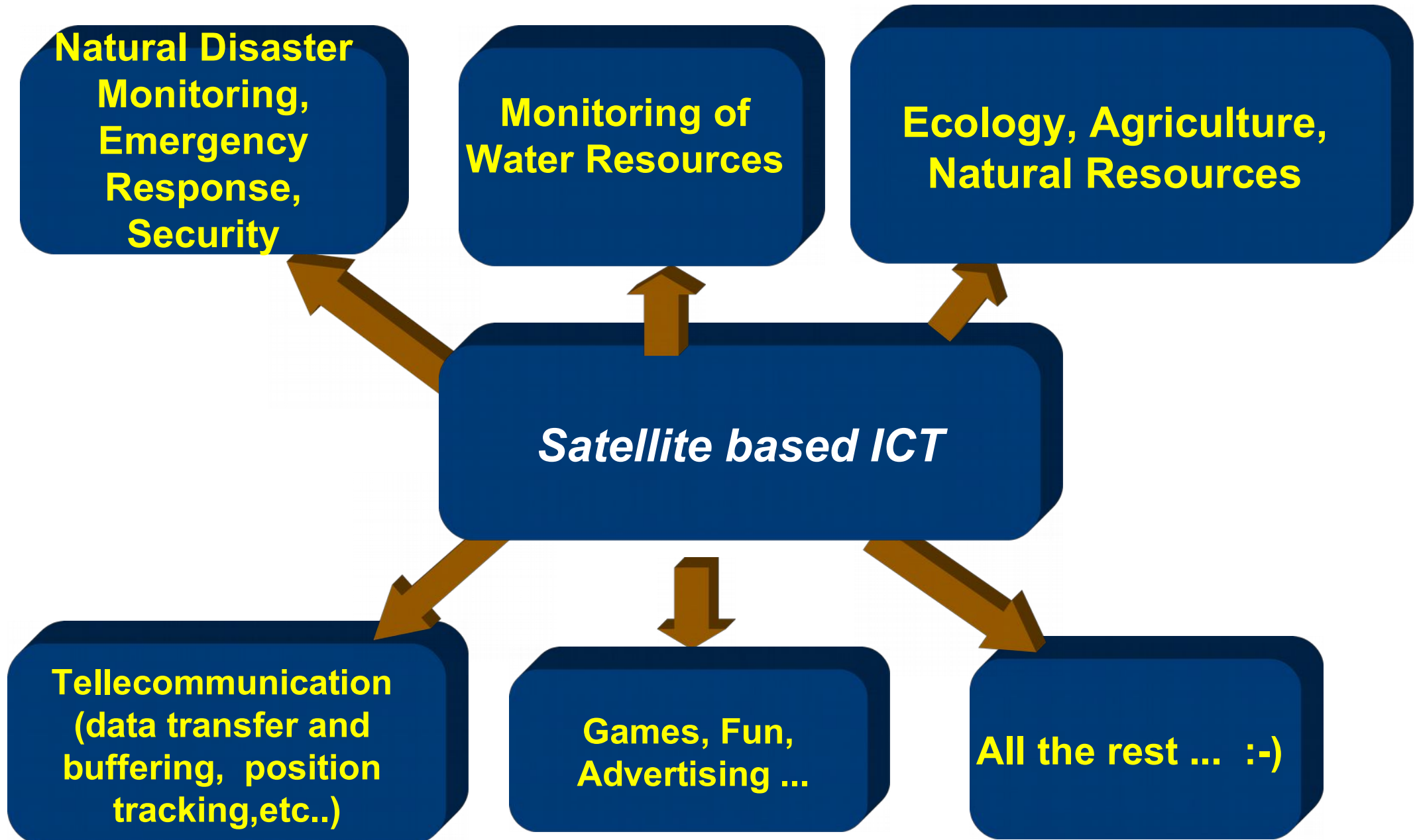
Cluster of Serbian Aeronautical Industry – UVIS

Bulgarian Air-Traffic Control Authority

Space Mission Control Centre, Russia



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- **Small satellite ICT services and business opportunities**
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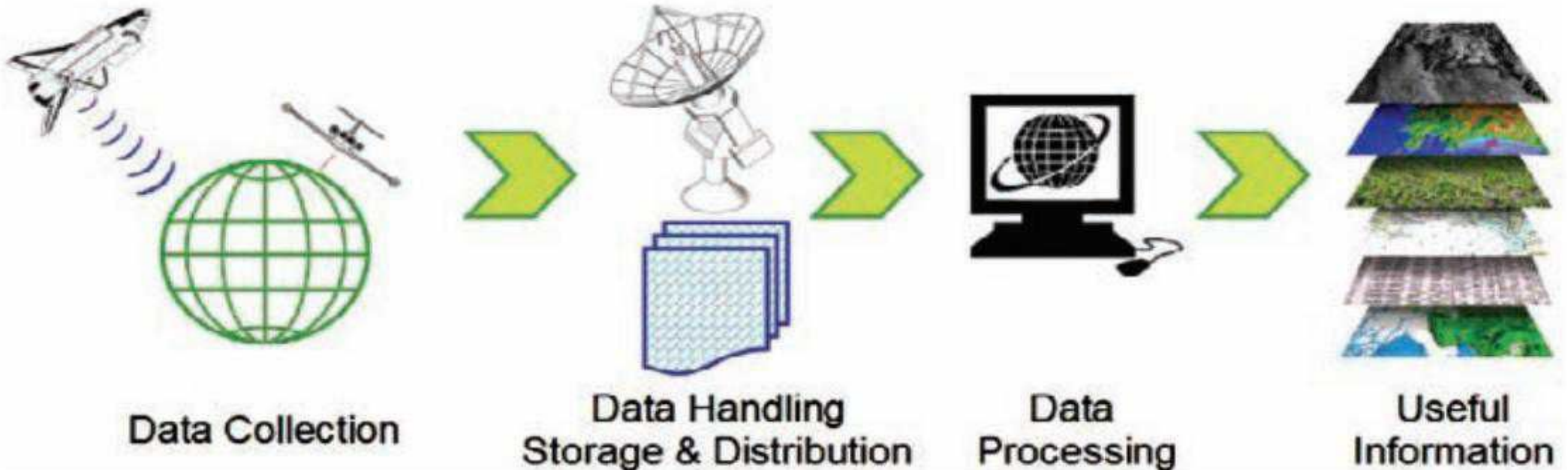


Classification of the main types of information obtained using satellite data

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

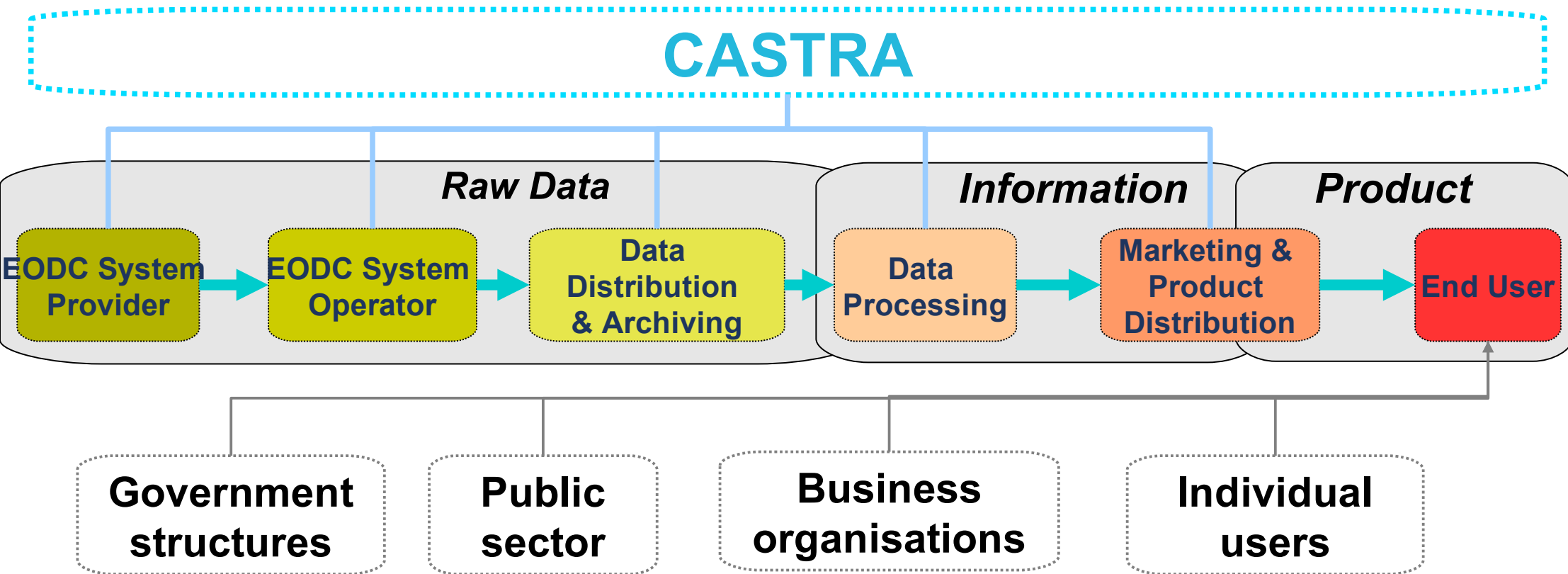
Satellite based process of generation of information rich data streams

in support of various customer needs, decision making, etc



Collection, processing and dissemination of data about Earth systems and human activities is crucial for various scientific, applied and commercial activities

Value chain in Earth observation and data communication (EODC) business activities

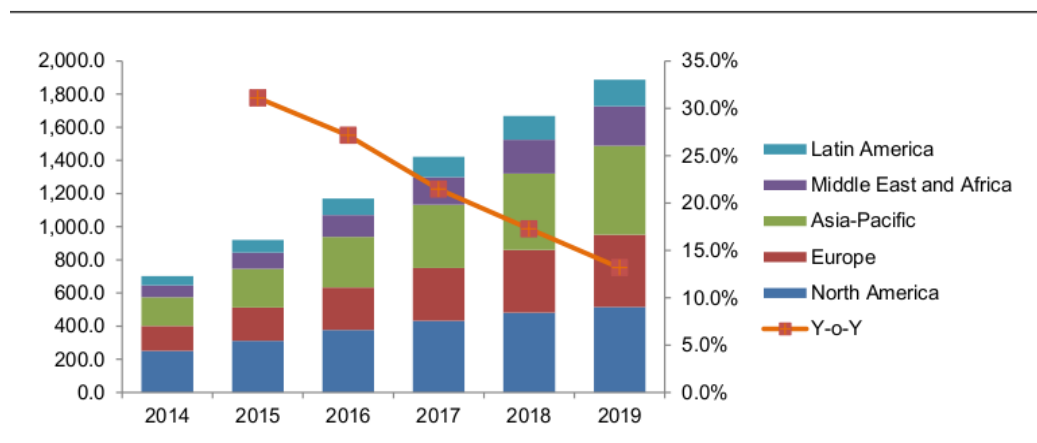


Multiple users at regional, national and international levels require for their business activities various information products supplied by an EODC system

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

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

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



source: a marketing agency

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

CASTRA's 2nd-ary target markets

CASTRA's MAIN target markets

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

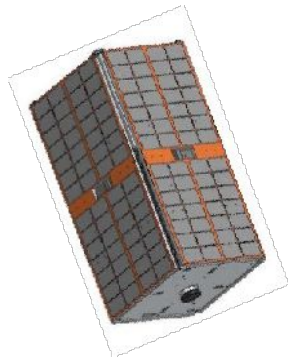
Region	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
NA	36.6	44.0	50.6	54.6	56.1	57.8	9.6%
EU	21.3	27.7	34.4	40.1	44.6	48.1	17.7%
APAC	26.2	33.9	42.0	48.9	54.2	58.4	17.4%
MEA	10.3	13.8	17.5	20.9	23.8	25.8	20.1%
LA	5.8	8.3	11.0	13.4	15.1	16.8	23.6%
Total	100.2	127.7	155.5	177.8	193.8	206.8	15.6%

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

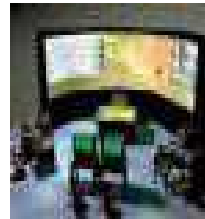
Region	2014	2015	2016	2017	2018	2019	CAGR
							(2014-2019)
NA	29.4	45.2	66.5	91.5	120.8	148.6	38.3%
EU	18.0	30.0	47.7	71.0	101.4	135.9	49.8%
APAC	20.4	34.3	55.4	83.4	120.8	164.1	51.8%
MEA	8.4	14.0	22.6	33.9	48.9	66.1	51.2%
LA	4.9	8.8	14.5	21.7	30.7	41.0	52.8%
Total	81.1	132.3	206.6	301.5	422.7	555.8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

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- **Main Functions of CASTRA's spaceborn ICT system**
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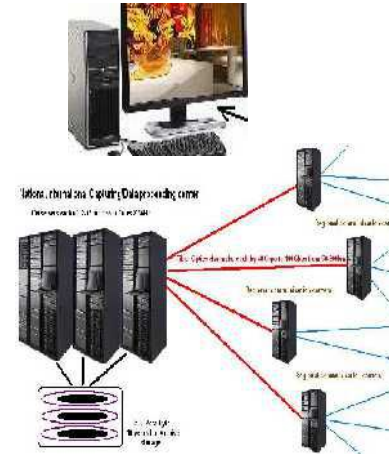
Components of a satellite based ICT system



+



+



+



Minisatellite <1000 kg

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

data and (fixed)

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

Qualified and motivated team of trained specialists

➤ **Microsatellite** <100 kg

Nanosatellite <10 kg

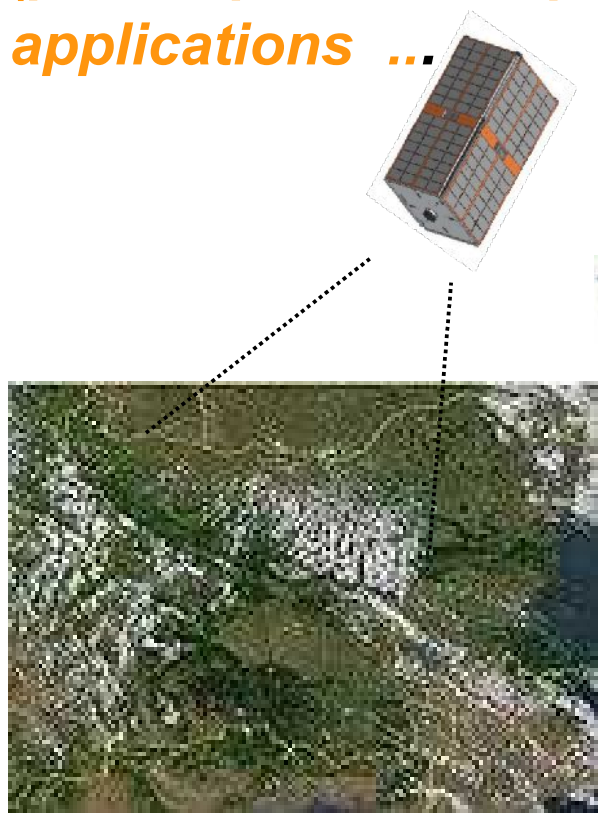
Picosatellite <1kg

The development and integration of all components requires close cooperation and joint efforts of organizations with complementary expertise

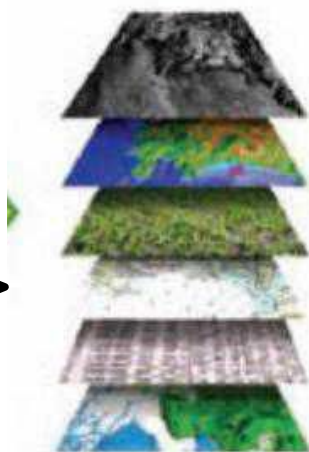
Application №1:

Remote sensing of Earth surface using a Hyperspectral sensor and generation of software and data products for the needs of different users;

EXAMPLES: Control of land and water surfaces, including vegetation and precision farming, ecology -related monitoring, Industrial infrastructure (power plants, oil pipes, etc) monitoring and control, security and other applications ...



Custom specific DATA products



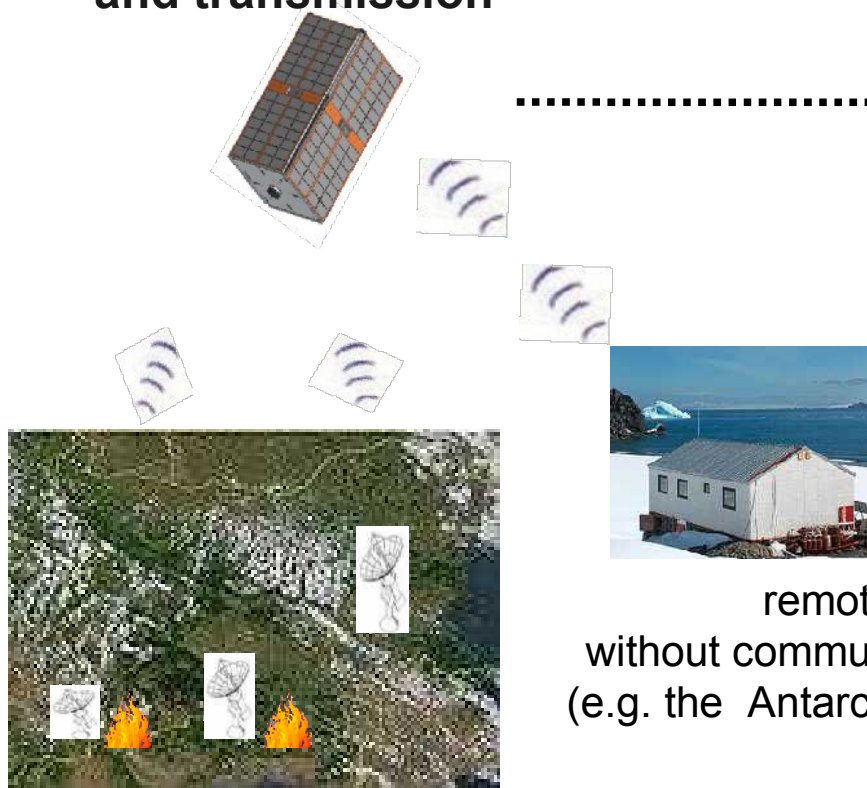
Camera minimal parameters

Better than 10m Ground Segment Distance (GSD) resolution from 600-800km orbit;
 400nm-1100nm spectral range
 Better than 25nm spectral resolution
 >2Mb/s C-band downlink data
 Separate camera: Live Video streaming

Application №2:

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

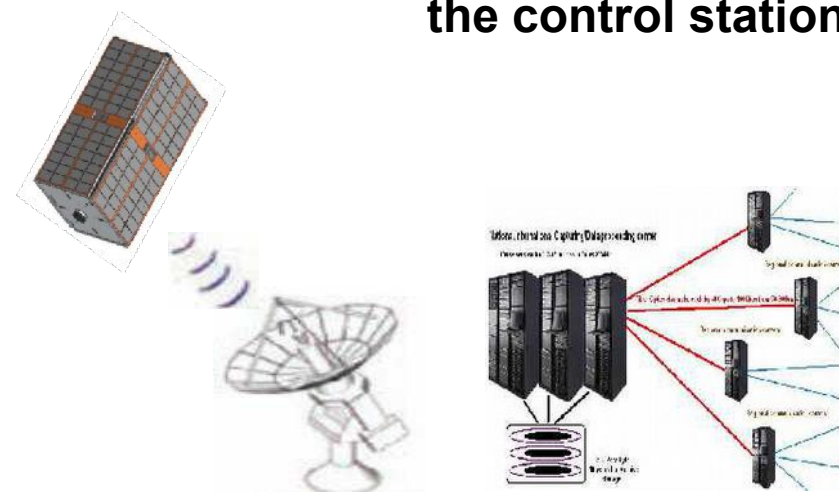
Position 1: data collection and transmission



remote user
without communication service
(e.g. the Antarctic based users)

on-ground sensor **networks**, **autonomous facilities** (e.g. solar power plants, etc)

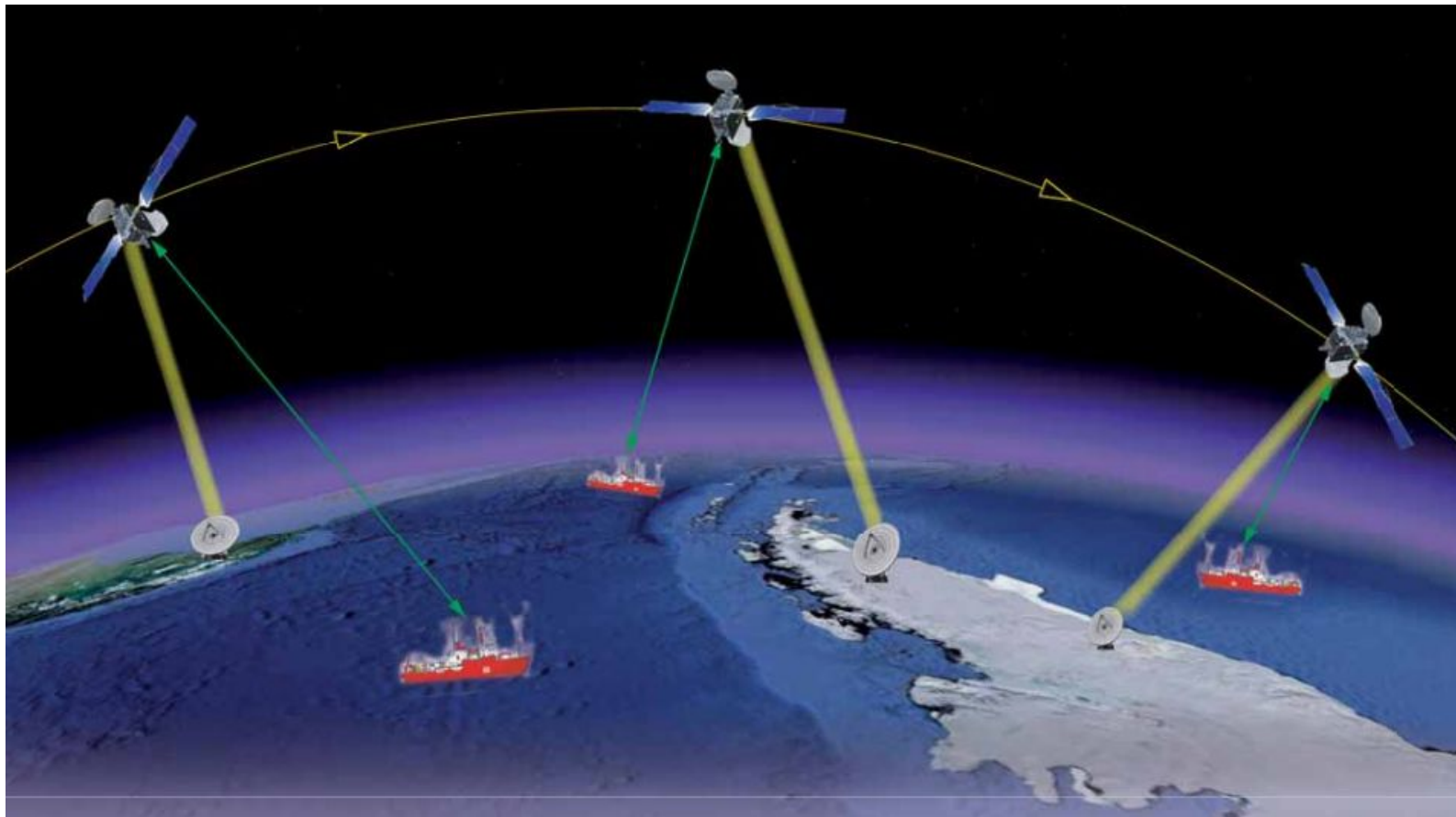
Position 2: data download/upload at the control station



Receiving /control/ station

Application №3:

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



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- **Project structure and information**

Government (partial) funding contract



МИНИСТЕРСТВО НА ИКОНОМИКАТА И ЕНЕРГЕТИКАТА

ОПЕРАТИВНА ПРОГРАМА
„РАЗВИТИЕ НА КОНКУРЕНТОСПОСОБНОСТТА НА
БЪЛГАРСКАТА ИКОНОМИКА“ 2007-2013 г.

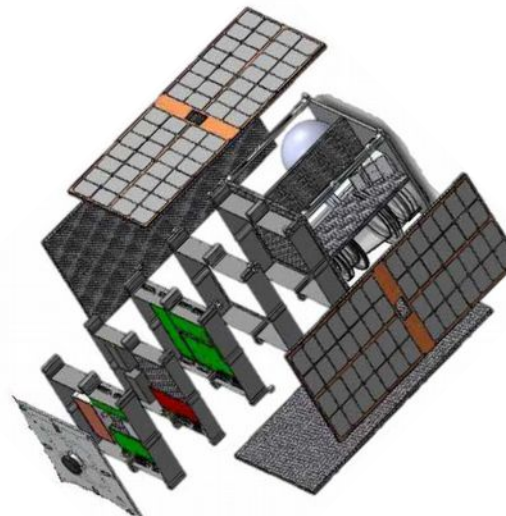
ЕВРОПЕЙСКИ ФОНД ЗА РЕГИОНАЛНО РАЗВИТИЕ

ДОГОВОР ЗА БЕЗВЪЗМЕЗДНА ФИНАНСОВА ПОМОЩ

Приоритетна ос 2:	Повишаване ефективността на предприятията и развитие на благоприятна бизнес среда
Област на въздействие 2.4:	Насърчаване на бизнес кооперирането и кълъстерите
Операция 2.4.1:	Насърчаване на бизнес кооперирането и кълъстерите

ОТКРИТА ПРОЦЕДУРА ЗА ПОДБОР НА ПРОЕКТИ, ПОКРИВАЩИ
ОПРЕДЕЛЕНИ ИЗИСКВАНИЯ ЗА КАЧЕСТВО С ОПРЕДЕЛЕН СРОК ЗА
КАНДИДАТСТВАНЕ: BG161PO003-2.4.02 „ПОДКРЕПА ЗА РАЗВИТИЕТО
НА КЪЛЪСТЕРИТЕ В БЪЛГАРИЯ“

Идентификационен номер на договора:	BG161PO003-2.4.02-0135-C0001
Регистрационен номер на проектното предложение:	BG161PO003-2.4.02-0135
Наименование на проекта:	"Развитие на високотехнологичен кълъстер в областта на космическите технологии и приложения"
Максимална обща сума на проекта:	3 683 981,40 лв.
Продължителност на проекта:	18 месеца
Брой страници	109 стр.



(satellite design illustration from Bologna University, Italy)

Approved project budget ~ 1.9M Euro;

- Only 50% will be reimbursed as grant by Bulgaria Government,

- 50% - CASTRA's own expenses → Investor needed;

- 100% of the budget needs to be available at some point in time to cover operational expenses

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)

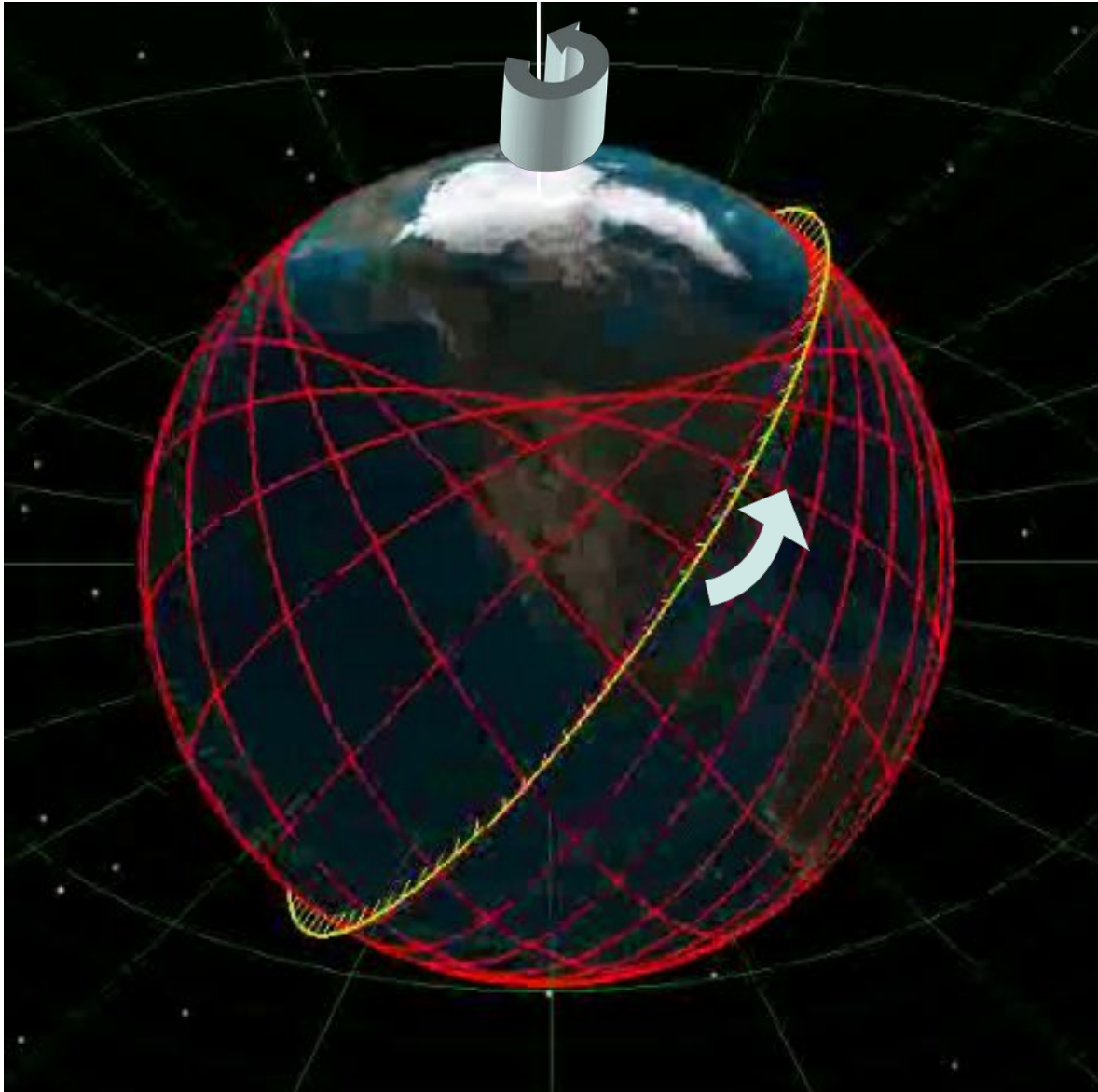
Laozi



LET US DO IT TOGETHER

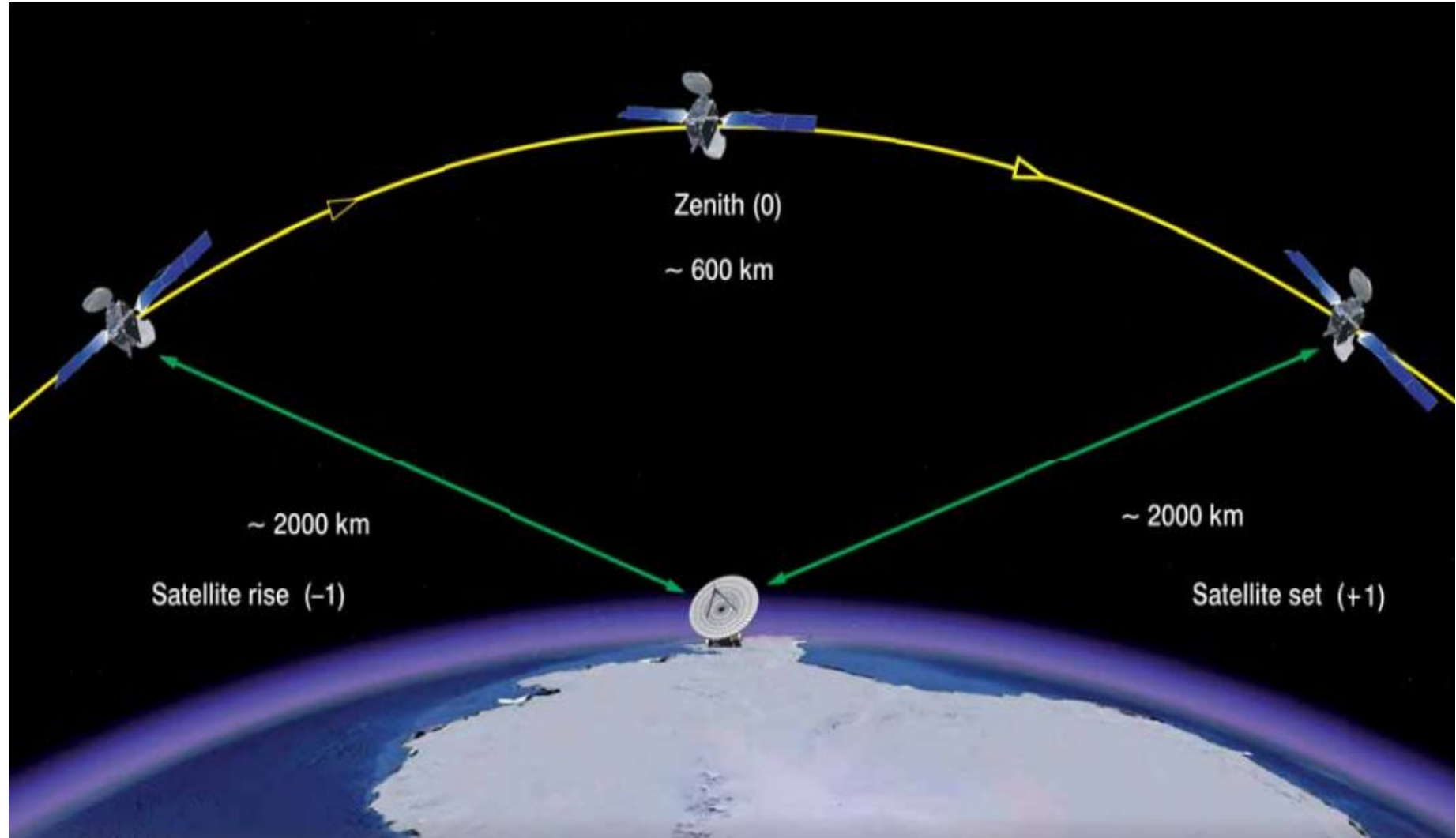
Additional Technology Information:

Example: Satellite orbit coverage

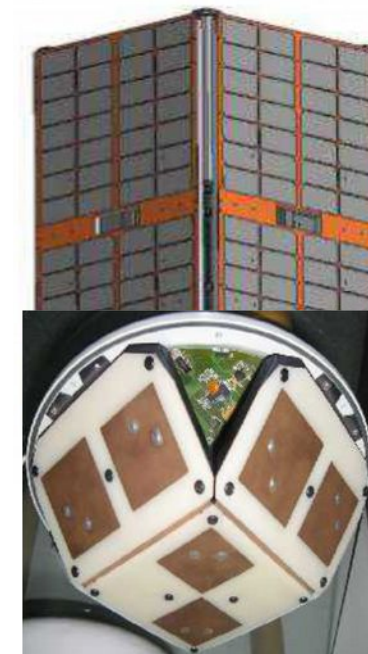
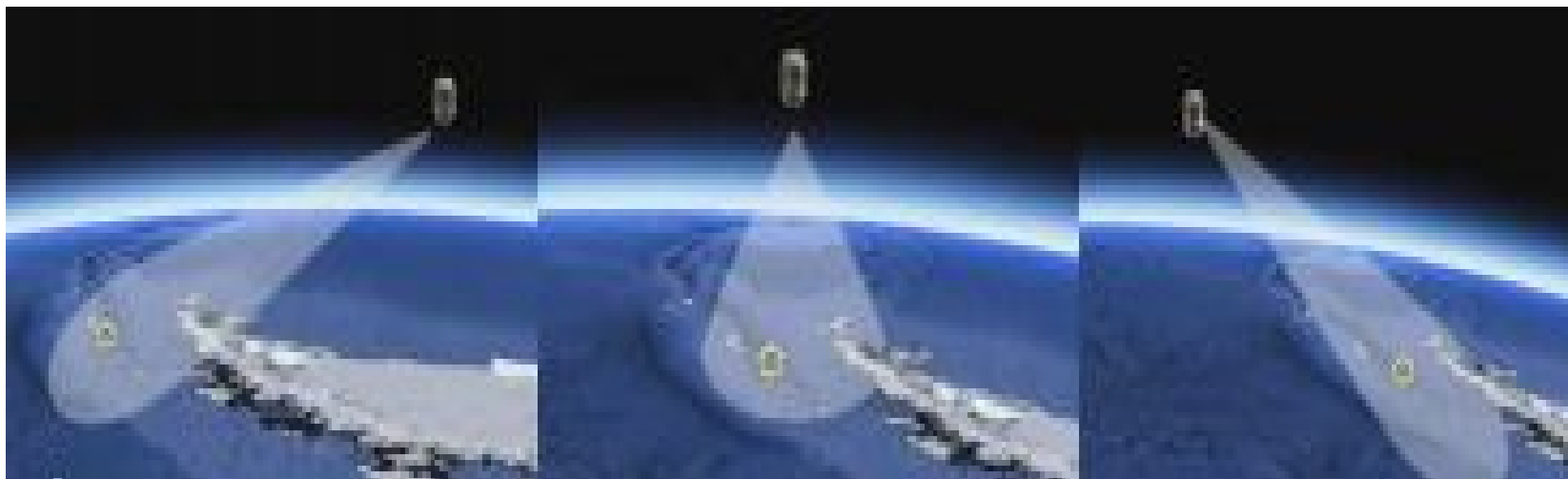


Example of a Sattelite Orbiting the Earth
 (click the text above to open on-line
 animation)

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



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.



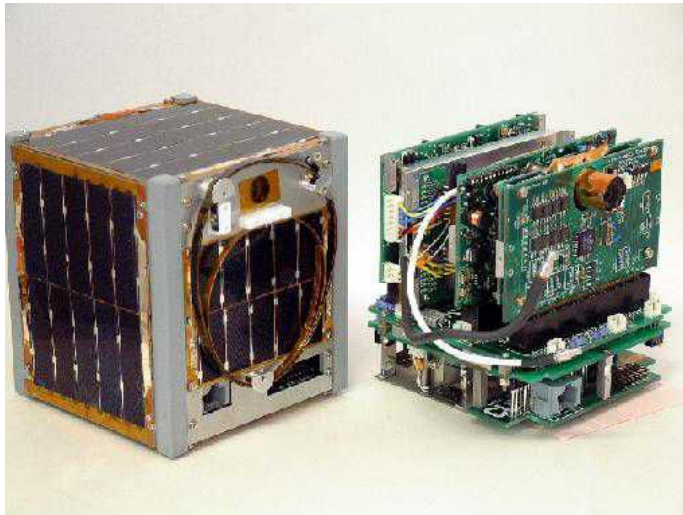
Using switchable or steerable antennas for both, Earth and satellite stations, the period „visibility“ time for high-speed data transfer could be increased up to 9-10 min per session.

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)

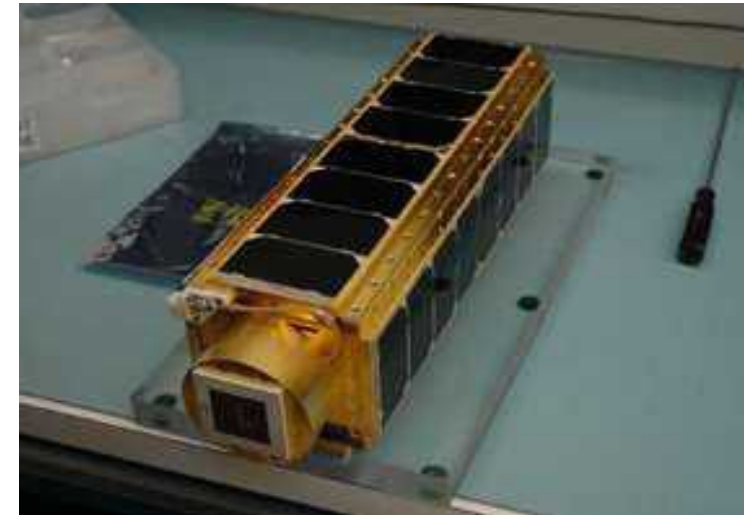
Assoc. Prof. P.Dankov, Sofia University

Nano Satellite Examples

Canada, Japan, 1 kg



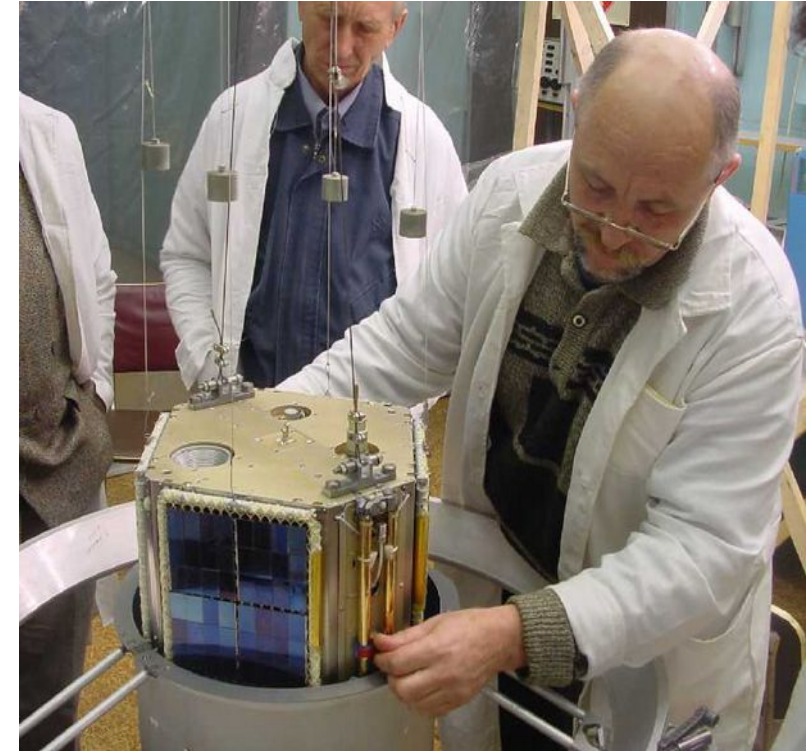
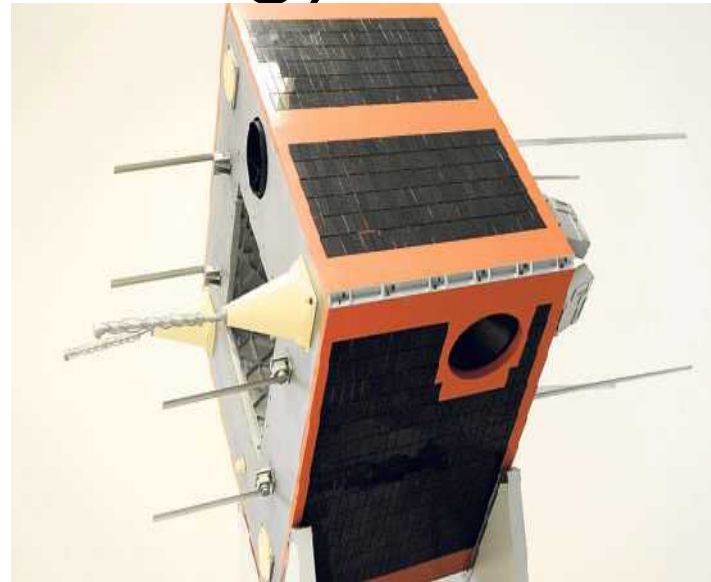
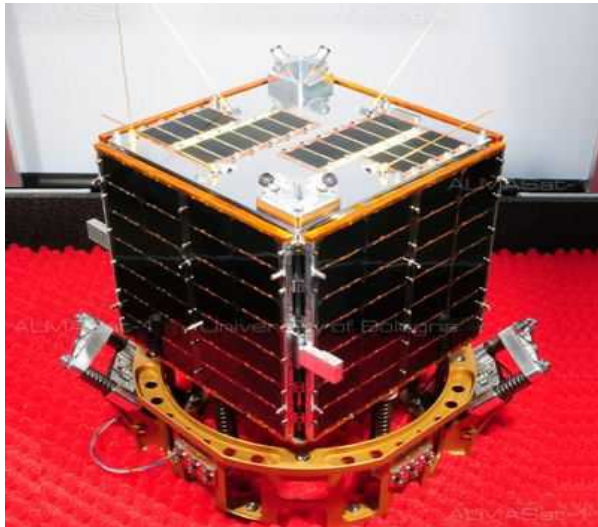
PharmaSat, NASA, 5.5 kg



Cube-sat family : 10cm X 10cm X N 10cm, mass < 10kg

Not -sufficient stability, payload capability, reliability and life-time (days to weeks). Not suitable for commercial applications

Micro-Satellite Examples (10-100kg)



ALMASat-1
12.5kg
(Bologna
University, Italy)

RASAT
95kg
(TUBITAK, Turkey)

CHIBIS
40кг
(RAN, Russia)

High potential for real scientific and commercial use, and use in satellite network systems – clusters or constellations



Mission Idea Contest for Micro/Nano Satellites Utilization

Certificate

This is to certify that

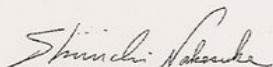
Plamen Dankov, Mario Gachev, Vesselin Vassilev,
Kaloyan Zlatkov, Zhivko Kiss'ovski, Dragomir Mateev,
Ognyan Ognyanov, Iliyan Krassimirov, Cvetan Simeonov
from

Sofia University "St. Kliment Ohridski"

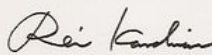
were selected as Semi-Finalist of
the 2nd Mission Idea Contest for Micro/Nano-satellite Utilization
with the submission entitled:

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

On July 1st, 2012 in Tokyo, Japan.



Shinichi Nakasuka
General Chairperson,
The 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



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