CONCEPTION OF THE INTERNATIONAL GLOBAL MONITORING AEROSPACE SYSTEM

(DRAFT)

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INTRODUCTION

This document - the Conception of the International Global Monitoring Aerospace System[1] (IGMASS) as a system for forecasting destructive natural phenomena and man-caused disasters in order to guarantee social, economic, seismic, environmental and geophysical safety, the prevention of other global space threats, as well as the development of information-navigation and telecommunication resources of the Planet for the benefit of all humanity - was developed by an initiative team of specialists of the International Academy of Astronautics (IAA) and Russian Academy of Cosmonautics n.a. K.E.Tsiolkovsky (RAKTS).

The proposals to create IGMASS for the first time was openly expressed at the International Conference «Modern Space Technologies for the Prosperity of Humanity» (Dnepropetrovsk, Ukraine, 2007). Later it was reported at the International Scientific Forums «Space for Humanity» (Korolyov, Russia, 2008), «Advanced Space Systems and Applications» (Shanghai, China, 2008), at the Mediterranean Conference on Astronautics (Tunisia, 2008) and also were at issue on the Academic Day of the International Academy of Astronautics (Glasgow, Scotland, 2008).

In the year 2009 a special international working group of experts (from the USA, France, Germany, Russia, Japan, Italy, India, China, Ukraine, Belarus, Bulgaria and Tunisia) was formed within the IIA to study the possibility and prospects of the IGMASS creating. The results of work of this group were discussed and strongly supported by the heads of several national space institutions, the managers of leading enterprises of the rocket-space industry, outstanding scientists and administrators from more than two dozen countries during the work of the First International Specialized Symposium on «Space and Global Security of Humanity», which was held in November 2009 in Limassol (Cyprus Republic).

The Conception includes the goals of the IGMASS creating, tasks that are expected to solve with its help, profile of the system, description of its functionality, including receiving, processing and dissemination of forecast data of aerospace monitoring, use of information resource of the IGMASS in order to solve urgent problems of humanity (eradication of illiteracy, distance education, disaster management, technological, human and environmental disasters), prediction of threats in and from outer space. The paper also presents the organizational and economic aspects of the establishing, development and full-scale use of the system, as well as the role of the UN and the International Academy of Astronautics in solving set of problems in realization of this ambitious project.

The Conception includes textual and illustrative parts that give the notion about the Project and its practical realization.

[1] Monitoring is a process of systematic or continuous collection of information on the parameters of a complex object or process.

I. GENERAL PROVISIONS

Sustainable development of modern civilization is prevented by set of threats of natural and man-caused origin, requiring the adoption of effective preventive measures to predict and protect against them. The most common sources of natural disasters are meteorological, climatic and tectonic phenomena: floods, typhoons, hurricanes, droughts, forest and grass fires, earthquakes, volcanic eruption, tsunamis, landslides, mudflows and avalanches. To predict their beginning, to warn about such phenomena and disasters they cause, accidents and (or) man-caused emergencies, in all respects is more benefitial than to respond to the following distructive consequenses[2]. Since a third man-caused emergencies is caused by natural phenomena, the effective monitoring and forecasting of geophysical situation in the vicinity of complex technical systems location would avoid many accidents and disasters.

In addition to the earth disasters the planet is threatened by the danger of solar, lunar and cosmic origin. The first are generated by solar activity and the movement of the Earth around the Sun and the Moon around the Earth, the second - by comets and asteroids. Thus, the periodic increase of seismic activity of the Earth's crust, atmosphere, ionosphere and magnetosphere was observed in accordance with the 11-year solar activity cycle[3]. The Moon has 2,2 times more powerful gravitational influence on the Earth than the Sun, creating a daily cyclic gravity loads on the Earth[4].

Over the past century our planet has been very toughly bombed by meteorites, comets and asteroids, including such dangerous as Tungusky, Sikhote-Alinsky or Brazilian, having warned against a possible global or regional disaster, which could surpass in scale all the known natural disasters. Especial danger presents the increasingly more frequent instances of crossing Earth's orbit with the trajectories of large but often unknown asteroids[5], collision with which could have fatal consequences for the planet.

Work on monitoring of solar activity and the comet-asteroid danger is still at the stage of scientific experiments carrying out with the help of ground-based optical and radar equipment. A number of satellites are used for basic research of solar-terrestrial relations, but the observations of the Sun from space are conducted just periodically. Monitoring of outer space for detection Earth-threatening comets and asteroids is limited by number and physical abilities of ground-based optical and radio telescopes [6]. Nowadays less than a half of two thousands of these cosmic «wayfarers» is

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[2] Thus, only in 2008 there were 137 natural and 174 man-caused disasters that had taken nearly a quarter of a million lives on the planet. According to international organizations from 1970 to 2000 the amount of damages, which the humanity costed natural and technological disasters, was about one and a half trillion dollars.

[3] The Sun is a magnetically active star with a strong electromagnetic field, the intensity and direction of which periodically varies. The Sun affects the Earth and in accordance with the rotation around its axis (27 days), the annual circulation of the Earth and its daily rotation. Variations of the solar activity and the solar magnetic field, exerting influence on the structure of the magnetosphere, the ionosphere and the Earth's atmosphere, causing a variety of effects which altogether cause the Earth auroras and geomagnetic storms, disrupting the operation of communications, electricity, as well as having negative impact on living organisms, including human-beings. Solar and lunar gravitational effects on the Earth's crust are the “trigger” of the earthquakes beginning and volcanic eruptions.

[4] The waves run through under the influence of gravitation of our natural satellite on the Earth's surface, pulling it to 0,5 m in the direction of the Moon.

[5] The Asteroid which approach to the Earth has being fixed by none of telescopes has blown up on the 8th of October, 2009 in atmosphere of the Earth on the altitude about 15-20 km over the Southern Sulawesi (Indonesia) province. According to NASA, destruction of this stone space object of a diameter about 10 m, entered into the Earth atmosphere at a speed of 20 km/s, has caused energy releasing equal to 50 thousand tones in the TNT, that has three times exceeded power of atomic bomb explosion over Hiroshima and has been fixed by the Western Ontario university observatory in Canada, which was in 16 thousands km from epicenter of the event.

[6] Maximum range of detection by ground-based facilities asteroids with a size no less than 1 km does not exceed 2-2,5 millions km. It means that at an average closing rate of the asteroid with the Earth (20 km/s) the collision can occur in less than 1,5 days, that is quite insufficient to make any effective security measures.

catalogized. Even the most powerful space telescope «Hubble» is able to detect 1 km size asteroid at a distance of not more than 40 million km (or little more than 20 days before the collision with the Earth) and even then provided the preliminary guidance to a potentially dangerous area in space that is quite impossible. With the current development of space technology and technologies for the detection of dangerous space objects at least during 5 days it is necessary to create a special space system of several «patrol satellites» at a distance of millions kilometers from the Earth.

In solving the tasks of forecasting threats arising both on the planet and from outer space, the particular importance has the continuous monitoring and comprehensive analysis of various parameters of anomalous geophysical phenomena, which precede the occurrence of natural disasters and man-caused emergencies. Today it is confirmed that such anomalous phenomena (precursors) occur in the Earth's magnetosphere, ionosphere, atmosphere and lithosphere, and can be identified, measured and used to predict the location, time and effort of a catastrophe[7]. In many countries, they work to establish ground-based and space-measuring tools for making such a forecast, as well as technologies for receiving, processing and transfer of the necessary information that could form the basis for future integrated warning systems of natural disasters and emergencies. <u>However, well-timed detection of signs and forecasting emergencies of space, natural and technogenic origin is possible only through the realization of large-scale international projects involving the complex using of both existing and prospective ground-based, air and space facilities.</u>

Concerted international efforts in this regard have been taken from the very beginning of the space age. The International Global Space System for hydrometeorological support (the project «Global Climate Observation System») has been created and currently functions. It is able to forecast coming disasters of meteorological origin and dangerous climatic anomalies (floods, typhoons, hurricanes and storms). Today, there are space systems, which are capable together for solving up to 300 basic and applied issues of Earth Remote Sensing (ERS), including problems of the consequences evaluation of natural and man-caused disasters. However, the instrumental composition, size and structure of ERS satellite constellations do not allow solving forecasting problems and early warning of coming danger[8].

The introduced «International Global Monitoring Aerospace System» (IGMASS) is a large organizational and technical system, which should be created under the UN guidance according to the principles of coordinated international cooperation and long-term partnership in the field of technical design, development and exploitation of ground-based and aerospace resources for solving a wide range of forecasting issues.

The Project realization in case of its practical implementation would initiate a new, unified strategy of space exploration aimed at achieving environmentally sound and socially sustainable development of the world community based on common, lasting values of life sustaining on the Planet.

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[7] The number of such precursors is more than 300. However the statistics confirming reliability of forecast according to precursors – is absent, only individual events are described. Therefore a forecast issue can be effective solved only by totality precursor's registration in the whole environments.

[8] There are also a number of international, regional and national projects and programs (UN-SPIDER, "Global Earth Observation System of Systems" (GEOSS), «The European Global Monitoring of Environment and Security» (GMES), «The System of Monitoring Natural Disasters in Asia Pacific Region»(Sentinel Asia),«The International Charter on Space and Major Disasters» (Disaster Charter), "The monitoring system of natural and technological disasters "Ionosat"(Ukraine), etc.), which focus more on providing mitigation of consequences than on their prevention, and still less - forecasting.

II. ANALYSIS OF THE DEVELOPMENT OF THE EMERGENCY MONITORING SPACE FACILITIES

In recent years the world pays much attention to the development of space systems of monitoring emergency situations. During more than five decades since the launch of the first ESV several generations of spacecrafts as well as target and communication equipment, new multispectral and hyperspectral devices, multispectral radiometers and radars, lasers, heliogeophysical equipment, computing, communication facilities and many other things have been developed. New technical and technological solutions have been passed flying training on the small and microsatellites. [9] As a result, modern observation satellites (ERS), which have mass from 300 up to 800 kg, solve effectively the issues of the atmosphere and the Earth's surface monitoring. Due to reducing mass and cost of spacecraft it has become possible to create multisatellite systems, providing high efficiency, reliability and integrity of monitoring of the various objects and processes.

Today the relevant projects and initiatives in various stages of realization are carried by the United States of America, Canada, EU countries, the states of South and South-East Asia. Both national and corporate space systems of monitoring and security are rapid developing. They include multipurpose multisatellite space remote sensing, communication and data broadcast, navigation, hydrometeorological and topogeodesic support and technological purposes as well. We can surely say that in recent years the world space industry and information infrastructure of observation has been formed with the participation of almost all the leading nations of the world (the USA, Canada, France, Italy, Germany, UK, Israel ,India, China, Russia and Japan), the international consortia and about 20 countries from all the continents of the Earth[10].

Space monitoring facilities are accepted relatively to divide into hydrometeorological and ERS systems, although during the solution of the applied monitoring issues the information from both systems is used jointly. Hydrometeorological systems are usually deployed in low polar geosynchronous[11] and geostationary[12] orbits; providing a meteorological monitoring and forecast of dangerous meteo-phenomena, can be only partially used to solve the monitoring issues of the geophysical processes, taking place in the lithosphere. Set on newly launched low-orbit meteorological satellites geophysical facilities can catalogue in the atmosphere and ionosphere only some of precursors of large earthquakes and heliophysical anomalies.

Today space remote-sensing facilities are represented by very extensive nomenclature of satallites: American (Landsat-7, EO-1, Ikonos-2, Quick Bird-2, OrbView-3, Geo Eye-1, World View-2, World View-3, USA-200); Indian (IRS, Cartosat-2A, Risat, IMS-1); Israel (EROS-B, EROS-C, TECSAR); French (Spot-5 and Jason-2); Japanese (Adeos-1, Adeos-2, Alos); Canadian (Radarsat-1 and Radarsat-2), Chinese (HJ-1A,-1B, Yaogan-5), Italian (Cosmo-Skymed, Cosmo-3); European (ERS-2, Envisat-1); German small and micro satellites (TerraSar-X, Sar-Lupe, Rapid Eye); Russian (Resurs DK). Algeria, Brazil, Nigeria, Taiwan, Thailand, Turkey, South Korea and the other countries also have their own space observation satellites, created in cooperation of leading space powers.

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[9] According to the current classification space vehicles with a mass of 100 to 1000 kg belong to the category of small spacecrafts (SSV), about 100 kg - micro-spacecrafts.

[10] In 2007-2008 the proportion of spacecrafts of communication, broadcasting, navigation and hydrometeorology exceeded 85% of the total number of all spacecrafts, launched by the world community to the Earth's orbit (92 of 113 spacecrafts in 2007 and 87 of 97 spacecrafts in 2008).

[11] Nowadays there are about a dozen of meteorological satellites belonging to the U.S. (NOAA-K, DMSP5D-3), ESA (Metop-A), China (FY-1D, FY-3) and Russia (Meteor-M) at the subpolar geosynchronous orbit

[12] Spacecrafts, created by the U.S. (GOES), European Union (Meteosat, MGS), Japan (MTSAT-1R), India (Metsat-1, Insat-3A), China (FY-2C, D, E) and Russia (Elektro-L in 2010) are placed in geostationary orbit

The IGMASS as a supranational system is proposed to create according to the principles of using the whole potential of modern space, including the international space projects of disaster monitoring, realization of which substantially contributes to the development of a global process of providing information on emergency situations in various regions of the Earth. Analysis of these projects shows that they all are mainly focused on the issues solving for identifying the harmful effects of natural disasters and emergencies. Thus, the final result of the international project Global Earth Observation System of Systems (GEOSS), based on a 10-year Plan (2005-2015), initiatived by the United States «Group on Earth Observations» (GEO), will become publicly available global infrastructure, which should provide a wide range of users a comprehensive, processed information of space monitoring[13] in scale of near-real time. Though due to the investment of recent years it has become possible to unite disparate monitoring tools and software to measure the physical, chemical and biological parameters that characterize the integrated occurring on the Earth potentially dangerous processes within GEOSS, this project is not intended to create its own orbital constellation that significantly limits the ability of solving the declared tasks of prediction of dangerous natural and man-caused phenomena by GEOSS.

The International system of space monitoring of natural disasters (Disaster Monitoring Constellation - DMC), for realization of which the International Consortium was created in 2002 (Algeria, GB, Nigeria, China, Thailand and Turkey), has low-orbit constellation in polar orbits of seven national British-developed 80-130 kg microsatellites, equipped with multispectral optoelectronic complex of medium resolution of 20-30 m. Microsatellites in the DMC are owned and operated by the United Kingdom, Algeria, Nigeria, Turkey, China, Thailand and other countries, exchanging, if necessary, space data. The possibilities of such system are very limited - it can catalogue only bypast major seismic or man-caused phenomena, it focuses on obtaining information only in the visible spectral range and is designed to provide operation information to the competent organizations and professionals only of those countries on whose territory an emergency situation arises.

The European initiative «Global Monitoring for Environment and Security» (GMES), aimed at creating its own European monitoring potential (the project includes France, Italy, Germany, Canada, Israel and a number of specialized aerospace companies in other countries), represents the EU contribution to GEOSS. This system should include space ERS, navigation and communication systems. In its framework it is applied to create a global environmental monitoring system of the planet, which will consist of analytical centers, ground stations and space constellation. Although some parts of the system are already in operation, it is still under development and completion of the orbital constellation formation is planned for 2012[14].

The orbital constellation GMES includes 13 observation spacecrafts, as well as satellites Gelios-2, Pleiades, Cosmo-Skymed, SAR-Lupe, Spot-5, Rapid Eye, DMC2 (Topsat 2) and TerraSAR-X[15]. In future, ESA is planning to create the satellites constellation (among them - SV Sentinel, ERS, ENVISAT, GOCE, SMOS, CryoSat-2, Swarm, ADM-Aeolus, Earth CARE, MSG, MetOp, JASON-2, PLEIADES), which are expected to equip with the C-band radars (for interferometric shooting), optical camera with medium spatial resolution (for mapping and hyperspectral shooting), optical equipment and radar altimeter (for detailed monitoring of ocean waters, the

[13] At the same time in GEOSS it is expected to integrate a various ground sensor equipment, weather stations, weather sensors, sonars and radars, a set of 60 satellites, including the navigation constellation «NAVSTAR», a powerful package for modeling, simulating and forecasting, as well as facilities for early warning of the population in countries and regions at risk.

[14] The program budget has been approved in the amount of 2, 2 billion Euros.

[15] Concerning the fact that in 2008 ESA initiated the deployment of a global space navigation system Galileo, it has its own space hydrometeorology systems (9 SV), communication and broadcasting (16 SV), as a part of the constellation GMES in some periods can operate for more than 70 satellite vehicles.

Earth's atmosphere with low and geostationary orbits). Although the GMES project has its own orbital constellation, development and acquisition of satellites for which, as well as the coordination of space-based assets of European national satellite operators is realized by ESA, but it does not include issues to identify precursors and forecasting of natural and man-caused disasters. In addition, a number of satellites in the GMES are designed to meet the challenges for defense departments and its resources are unlikely to be used on the regularly basis for the purposes of international global monitoring.

Initiated in 2000 by ESA and the French Space Agency the International Charter «Space and Major Disasters», to the realization of which have joined space agencies and organizations of Argentina, India, Canada, the USA and Japan, wants to create a unified space data system, designed to provide the necessary information to victims of natural or man-caused disasters. Although the orbital segment of the project includes national ERS satellites of member-states - ERS, ENVISAT (ESA), SPOT (France), RADARSAT (Canada), IRS (India), GOES (USA), SAC-C (Argentina), ALOS (Japan), due to its specific objective focus (coordinated use of space facilities in case of natural or man-caused disasters and providing free space monitoring data to the affected countries); the Charter does not solve a wide range of forecasting issues of occurring natural disasters on the Planet.

The project «Sentinel Asia», proposed in 2004, includes 51 organizations, as well as 44 agencies from 18 countries, provides for the creation in the Asia-Pacific region (APR) control and liquidation system of natural disasters consequences with the use of opportunities of space ERS technologies in a quasi-real time, in conjunction with GIS-mapping technologies and modern global network «Internet»[16]. However, considering the limited size of the on-board equipment using in the SV-project and the specifics of the orbital constellations construction, the solving issues to forecast natural and man-caused phenomena on a global scale within the project is unlikely to be possible.

Concluding the analysis of the status and prospects of development of space facilities and monitoring systems of emergency situations and their objective focus, it will be observed the complete absence such issues as prevention of global planetary threats (related to the meteoroid and asteroid danger, solar activity, etc.), solved with their use.

III. PURPOSE OF THE IGMASS CREATION AND THE FUNCTIONAL TASKS, SOLVING WITH ITS USING

The International Global Monitoring Aerospace System (IGMASS) is being created to provide well-timed warning of the international community about coming emergencies as well as natural and man-caused disasters through a global and operational monitoring and forecasting with the use of scientific and technical potential of earth-based, air and space monitoring all over the world and the further development and gradual integration of navigation, telecommunication and information resources of the Planet for solving global human issues.

The purpose of the IGMASS is a global and effective forecast of potentially dangerous natural and man-caused disasters on the Earth and in outer space, based on integrated global aerospace monitoring resources.

The main tasks of the system, which will be solved by using ground, air and space facilities, are:

[16] The architecture of the project is being developed with the possibility of receiving and processing voluntarily submitted by Asia-Pacific countries imagery and textual information from satellite remote sensing systems, including geostationary platform.

✓ continuous and uninterrupted space monitoring of the lithosphere, atmosphere and ionosphere of the Earth, near-Earth space to identify early signs of dangerous natural and man-caused disasters;

✓ obtaining, preprocessing on-board and transfer of monitoring data from satellite to the ground receiving stations;

✓ compilation and complex using of global monitoring data, received from space, air and earth assets, processing with use of national, regional and international situation centers, and its interpretation, storage and display;

✓ operating delivery of information on identified natural and man-caused threats to the relevant organizations of the countries at risk and the UN specialized structures;

✓ guaranteed navigational and telecommunication support of customers all over the world in the interests of making emergency response, disaster medicine, human operations; creating a system of transport corridors, optimize the movement of people and goods; eradication of illiteracy, development of distant learning for preservation of cultural values;

✓ warning about global threats in and from outer space: asteroids and meteoroid threat and the abnormal phenomena of different nature;

✓ gradual formation of a united, planetary «information security space» in order to reduce the global risks and emerging threats.

Concearning objective focus of the IGMASS, the primary tasks of the system should be: identification of earthquake-prone areas, detecting and documenting the precursors of dangerous geological phenomena for real-time warning of their coming, their evolution in time and space and the subsequent permanent control of environment danger (seismic, aggressiveness, variability, etc.) on man-caused systems and its components[17.]

Appreciating the necessity of optimizing the terms of the IGMASS creation, other issues, assigned to the system, will be solved in two stages. The first stage - telecommunication and navigation support activitivities for decreasing of negative the consequences of disasters, humanitarian operations; development of distant learning and specialist training in various fields. The second stage - long-range objectives of preventing global threats in and from outer space and the gradual formation of united «information security space».

IV. PRINCIPLES OF IGMASS CREATIOIN AND GENERAL REQUIREMENTS TO THE SYSTEM

To make short-term forecasting of natural disasters and man-caused disasters it is necessary to ensure efficient delivery, specialized processing and transmission of decision-makers, special information concerning the evolution of the parameter changes of the Earth's lithosphere, atmosphere and ionosphere and near-Earth space that can be achieved by low-orbit and GEO's satellites constellation complex using, equipped with specialized on-board facilities, combined with the target aircraft facilities as well as the onland radar control tools and effective ground infrastructure for receiving, processing and analysis of information.

The IGMASS is based on the following basic principles:

✓ absolute observance of the norms and principles of the international space law, as well as the relevant single and multistate responsibilities in the field of space activity;

[17] Some dangerous man-caused disasters occur as a result of the gradual merging and interaction of complex technical systems with the natural environment (geotechnical processes and systems).

✓ the widest possible use and ensuring the continuity of the results of relevant research and development, conducted in the framework of the international space programs of aerospace monitoring;

✓ stage-by-stage approach of the creation system parts taking into account the priority tasks of forecasting global natural and man-caused phenomena, technological progress of developments in the field of aerospace monitoring and using resources;

✓ priority development of the ground infrastructure system based on full scale working out (testing practice) basic technologies and software and hardware facilities of aerospace monitoring forecasting;

✓ wide information, organizational and technological cooperation of the IGMASS own orbital segment with ground and air facilities of monitoring and with existing space ERS, navigation, communication and data broadcast systems.

The IGMASS must meet three basic system requirements, based on the main purposes and tasks.

Firstly, to implement the global monitoring of the current state and dynamics of potentially dangerous processes, early detection of their expressions, updating coordinates of the disasters origin areas with prior assessment of impacts on the basic ecosystems and human population in order to develop adequate measures of prevention and protection.[18] And herewith the following should be provided:

✓ search, identification and cataloging of earthquake-prone regions, active faults of Earth's crust, updating of the global maps of seismic hazard, including the precise mapping and identification of signs of such activation[19];

✓ receiving and transmission of information by ground-based sensors from meteorological, seismic, hydrological, geophysical stations and observation points in earthquake-prone regions;

✓ cataloging precursors of dangerous geological phenomena, notification of their manifestations, positioning of seismic objects on the Earth's surface;

✓ regular monitoring of the development of seismic phenomena, fixing their devastating effects on a real-time scale;

✓ mapping areas for construction of potentially dangerous industries objects, monitoring the construction progress of these objects;

✓ monitoring the impact of geotechnical processes on the largest and most dangerous man-caused objects and systems, as well as their environment;

✓ warning of oncoming meteorological, seismic, hydrological, geomagnetic and other dangerous phenomena, threaten the technical objects, and of the other unauthorized interference in their work;

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[18] Criteria for forecast requirements for IGMASS can be divided into four groups, which are long-term (years, decades), medium-term (one year), short-term (up to 10 days) and operational (day-hour) types of forecast. Short-term and operational forecast applies to dangerous meteophenomena, medium - to the prevention of the meteoroid, asteroid dangers and natural disasters of geological origin, the long-term forecast - global natural disasters of geological origine.

[19] Nowadays it is known a number of anomalous phenomena in the atmosphere, ionosphere and the Earth's surface, which potentially can be considered as signs of oncoming seismic phenomena. It is a sudden change in the concentration of electronic components and arising of large-scale irregularities in the F2 layer of the ionosphere, and ultra-high-and-low frequency electromagnetic waves, abnormal changes in quasi-steady electric field and magnetic field; variations in the composition, concentration, flow rate and temperature of the ionospheric plasma; intense glow of the atmosphere at frequencies corresponding to the vibrational spectra of atomic oxygen and hydroxyl; emissions of radon and metallized surface of aerosols in the atmosphere; raising the Earth's surface temperature, forming of aerosol clouds above the active faults, etc.

✓ solar weather and gravitational action of the Moon and the Sun monitoring, in order to forecast the effects of geomagnetic situation;

✓ The near-Earth space control for the meteoroid and asteroid threat warning[20].

Secondly, to provide an opportunity to inform in- time the competent authorities of the concerned countries and the international community about oncoming in the short term dangerous natural and man-caused disasters.

Thirdly, to provide a wide range of consumer with high-precision navigational and telecommunication services for monitoring progress in emergency response, conducting evacuation efforts, conveyance of persons and goods and solving other social and economic issues (distant education with using advanced space and information technologies, disaster medicine, training of relevant experts of the IGMASS and specialists in other areas of science and engineering).

V. STRUCTURE AND FORMATION OF IGMASS

IGMASS as a large organizational and technical system is intended to integrate in its structure, along with specially created, its own specialized space segment - microsatellites constellation with onboard detection equipment for early signs of destructive disaster fixing, both existing and future national and international air and ground-based facilities, including contact and remote sensors, the ERS space systems, communication and broadcasting, meteorological and navigational support (or allocated information, organizational and technical resources), together with appropriate ground infrastructure of insertion, deploying and maintenance of spacecrafts, as well as receiving, processing and expansion of monitoring information. This will provide the worldwide caverage, the complexity of emergence monitoring of disaster developing, occurring on the Earth and in near-Earth space, reliable forecasting of their occurrence with the purpose of taking the necessary measures in the world community to to prevent or mitigate its devastating impact, well-timed evacuation of people, saving material resources and cultural values, along with the using navigation, telecommunication and information resources of the world community to solve the entire range of up-to-date issues of Humanity.

The IGMASS own orbital constellation and attracted information resources of existing space systems, possessing the ability to monitor the Earth's surface, atmosphere and near-Earth space, will provide a worldwide warning of dangerous geophysical and meteorological phenomena and efficient data transfer to monitor their precursors to almost anywhere in the world.

Space-based and air-born facilities of the IGMASS should also be used to obtain data on the situation in areas of large-scale destruction (state of electric system, pipelines, roads, etc.) for future forecasting of adverse climatic and meteorological conditions, seismic disturbances (crustal movements, landslides and rockfall, caves, mudflows, avalanches, etc.), that could threaten the integrity of technical facilities. Self-importance will have the task of all kinds of anomalies cataloging, allowed in the construction and exploitation of the objects (emissions to air or water poisonous and radioactive materials, flammable gases, dust, aerosols, etc., unauthorized access to pipelines, disruptions in transport infrustructure, etc.)

Ground-based component of the IGMASS must provide collection from space-based and air-born facilities of objective, telemetry and navigation information[21], the deployment and replen-

[20] Space warning subsystem on the asteroid and meteoroid risk within IGMASS in conjunction with existing and prospective ground-based facilities should ensure high reliability of objects detection larger than 50 m at distances of at least 15 mln km.

ishment of the space echelon of the IGMASS using space-rocket complexes on ground, sea and air bases.

Specially created (own) space segment of the IGMASS will consist of low-and high-orbit constellation of small and microsatellites, placed in the areas of low, sun-synchronous (polar) orbits and the GSO respectively. On low orbits would be deployed MSV, equipped with consistent monitoring facilities and specialized geophysical equipment (side-looking radar and interferometry, multifrequency, polarimetric and multistation radar with antennas with synthesized aperture). Consistent microsatellite platforms for solving heliophysical observation issues as well as experiments with advanced scientific equipment and communication and broadcasting, will be available in the area of the geostationary orbit. Developments, such as those that would be required to create low-orbit observations MSV are already underway in many countries: Russia in cooperation with companies from the UK, Israel, Germany, France, Italy and the USA; Canada in cooperation with companies from the USA and several European countries.

Engaging into specially created (own) space segment of the IGMASS national and international facilities - geosynchronous and low-orbit space complexes and systems of hydrometeorological support, ERS, communication and broadcasting ground-based complexes of receiving, recording and processing of space monitoring information - will provide an integrated picture of precursors of natural and man-caused disasters.

With the prospects of using opportunities of foreign and international systems the space segment IGMASS will include the following special equipment:

- ✓ geophysical monitoring facilities of solar activity and the identification of physical abnormalities of the Earth's magnetosphere, ionosphere and atmosphere;
- ✓ radar S and X-range with multiple polarizations;
- ✓ microwave radiometers (from 10 to 200 GHz and more) for the registration of small gases components in temperature, humidity and other atmospheric parameters;
- ✓ optoelectron devices with high and medium spatial and radiometric resolution for the Earth's surface temperature regestration;
- ✓ radio-tomography facilities of the ionosphere using signals of low-orbit navigation satellites and ground receiving stations;
- ✓ heliophysical equipment for the solar activity anomaly registration;
- ✓ powerful optical telescopes to monitor the asteroid and meteoroid threats [22] and the efficient warning about the dangers of «space debris».

Air-born segment of the IGMASS will include national air-born facilities (airplanes, helicopters, dirigibles, meteo-sounding balloon, pilotless aircrafts), used by the project member-states. Intensively investigated in recent years pilotless aircrafts systems of remote sensing can take in the air-born segment of the IGMASS an important place, especially in solving forecasting issuess of large-scale man-caused disasters.

Ground segment of the IGMASS will include ground facilities to provide orbital position of satellites and their control, sub-system, that provides consumers with monitoring information and special complex of navigation and information support sub-system of the IGMASS.

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[21] The space subsystem of the asteroid and meteoroid dangers prevention in structure of IGMASS in aggregate with existing and perspective ground facilities should guarantee high detection reliability of potentially objects in the size more than 50 m on distances not less than 15 million km.

[22] One of the projects in deep space is expected to deploy three satellite-telescopes: two of which are placed in the orbit of revolution of the Earth around the Sun, providing the detection of large asteroids at distances up to 10 million km, and the third - with a long-focus telescope (17 m), located in the lagrangian libration point between the Earth and the Sun, providing accurate determination of motion parameters identified, objects threaten the world and the forecast of dangerous closing with the Earth at least in three days).

The range of the ground facilities to provide orbital position of satellites of the IGMASS should give a possibility for single, passing and associated insertion of small and microsatellites for deployment and maintenance of the own space segment of the system with the use of ground, sea and air bases.

Ground control complex of the IGMASS should guarantee the collection of the telemetry data from its own orbital segment, conducting flight control missios, developing long-term and short-term plans for the application of orbital constellations, work programs and corrective commands of onboard equipment, etc.

Ground-based global sub-system provides consumers by monitoring information that is used for obtaining, structural recovery, processing, storage and circulation of all types of data as well as planning of special applications of the system, that would represent a complex of interconnected and topologically distributed ground-based receiving facilities, multi-level processing, storage and transmitting of the monitoring and forecast data, obtained from space and ground-based information sources. The main sub-system within IGMASS will have a hierarchical, three-level structure with a radial topology, combining international and national monitoring and crisis management centers as well as ground stations for receiving the monitoring information.

The highest level of the sub-system will include international centers for control during emergency situations, situated in Russia, Asia, Europe and America. Medium level of the hierarchy of the subsystem includes national centers for control during emergency situations; these centres have to interface with the centres of the highest level. Lower level of the sub-system will consist of ground stations which provide space data from ground and air-born facilities, as well as reception of space monitoring information of national and international affiliation. For the effective functioning of the IGMASS it is necessary to deploy at least five similar stations with international status, spread across the Globe. In the interest of direct data support of national management centers in crisis situations, member-states of the Project can deploy such stations on their territories with their own funds.

Ground special complex of the IGMASS' navigation and information supportsub-system is designed to create a unified navigation and information space, within which an unlimited number of mobile and fixed objects are able to automatically and accurentlydetermine the whereabouts, based on signals from satellite navigation systems GLONASS, GPS NAVSTAR and Galileo. The structure of ground special complex will include «integrated telematic system of transport corridors»[23], designed for evacuation activities in case of natural disasters, enhancing the transportation network throughput, ensuring traffic safety, protecting the environment and increasing cargo transportation as well as peorle movement efficiency via transport corridors.

Important independent line of information and telecommunication resources of the IGMASS will become systems of distant learning and supplying disaster medicine, which will provide a qualitative expansion of opportunities for citizens to obtain member-states of the Project of various types of education directly to the location, as well as emergency medicine in case of natural and man-caused disasters.

[23] One of the deep space projects are supposed to develop three satellite-telescopes: two of which based on the revolution of the Earth round the Sun orbit, providing detection of large asteroids on distances of 10 million km., and the third - with the long-focal length telescope (17 m.), based on Lagrangian point between the Earth and the Sun, providing high-precision definition of movement parameters of objects revealed and threatening for the planet and earliness of forecast of their dangerous rapprochement with the Earth (not less than three days).

VI. ORGANIZATIONAL AND TECHNICAL BACKUP ATTAINED ON IGMASS PROJECT REALIZATION

The practical realization of IGMASS is carried out by following complementary destinations:

1. Researching in the international cooperation. Along with definition of system shape and basic components data elaboration (Academy of Cosmonautics n.a. K.E. Tsiolkovsky in 2009 was conducted to research on determining of IGMASS shape and organization of its functioning, the results of which are five volumes, totaling over a thousand pages), system works on hardware implementation issues for revealing primary signs of disasters of seismic origin were launched. The complex of technologies and the scientific and technical solutions providing an outer space experiments conduction (a material-friction, atmosphere limbic sensing, measurement of space radiation flows), creation of radiation-hard base elements of micro satellite equipment, braked air-bag elements of lowered workload, etc. is developed.

In February, 2010 between IGMASS Project management and group of the Canadian-American (CANEUS) International companies had been signed «Memorandum of Understanding», included IGMASS promotion at the International level regarding the cooperation with relevant the International Organizations and Projects («SPIDER-UN», «GEOSS», «DMC», Charter «Space and Major Disasters», etc.), definitions of rational shape of the IGMASS ground infrastructure (including collection, processing, storage and expansion of monitoring information); creation of IGMASS own orbital segment, based on small and micro SV, including cooperation development of the Russian micro satellite, created by RACT n.a. K.E. Tsiolkovsky, and group of companies CANEUS of cooperation researching, financed through the international investment vehicles.

2. Development activity in the framework of «Multipurpose System of the Union State Russia-Belarus» creation as prototype of IGMASS main segments. Base elements of Russian (Jubileiny, Moscow region) and Belarusian (Minsk) segments of two multinational information systems: providing Russian and Belarusian consumers with monitoring information as well as Integrated navigational and information system providing the highway traffic control and management – are system and structurally thrashed out to the closing stage. In Pushkin area and in Jubileiny town of Moscow region navigational and information (telematic) technologies pass practical approbation.

3. Development and full scale working out of a specialized ground infrastructure elements for reception and processing satellite monitoring information. Thus, a high-informative reception complex, including a reflector in diameter of 9 m, providing diplex reception of the information from the Russian and Belarusian Earth remote sensing satellites in range of frequencies of 8,025-8,4 GHz with speeds up to 123 Mbit/s, is created.

The vehicular complex «Sadko» is entered into experimental operation, allowing to provide fire, medical service and Emergencies Ministry with space monitoring special data on emergency situation in separate region of the Earth, as well as data received from own on-board sensor systems.

The vehicular complex is equipped by several subsystems of reception and data expansion in real time, first developed and introduced by soft mechanism of efficient complex processing of monitoring information, obtained from space and ground-based sources that provides possibility of a complex batch operation during not less than two weeks.

The new generation telemetry equipment providing high-efficiency reception of information, obtained from MSV in unequipped regions including mobile telemetry tracking station equipment, transported by hand luggage is created; hardware and software complexes of processing and

space data display using GIS-technologies; the station of high-definition positioning subsystem, equipped with data security facilities within information exchange, which allows to define a base line with a margin error from units to tens centimeters.

4. Designing and prototype testing of small and micro SV for IGMASS orbital segment. Thus, particularly, micro satellite design ERS «Union-sat-O» is finished as well as its dimensional model is developed for dynamic tests. Start of experimental model of such micro satellite RN "Rokot" is planned in 2011 together with SV "Koronas-Nucleon". On-board facility including special and private systems with permission to 2,5 m. at lower mass and dimensions parameters in comparison with existing analogues and an operational resource of 10-12 years is created for ERS micro satellite of new generation. The considerable technological advance in new propulsive devices of the micro satellite creation, based on modern technical solutions is created: ablative, laser-plasma and oxygen-hydrogen types, which should be used for orientation and stabilization MSV, an orbit correction, realization of intertribal transfer as well as in structure transfer orbit stage and space tows.

5. Active promoting of IGMASS Project at the international level and attracting foreign participants (in the framework of the United Nations and the International Academy of Astronautics forums).

VII. STAGES OF IGMASS PROJECT REALIZATION

Taking into consideration the fakt that the problem of forecasting natural and man-caused disasters is of an obviously international character as well as necessity to solve a number of scientific and applied tasks dealing with development, test and utilization of up-to-date facilities as premium efforts towards the promotion of the Project, the following organizational steps should be taken:

1. To provide the IGMASS Project with an adequate organizational, political and perhaps financial support from the UN, which will be necessary for its future practical realization.

2. To promote the IGMASS Project at the interstate level by the International Academy of Astronautics as an organization, which will accumulate world scientific potential in the field of space research for the benefit of all humanity.

3. The ultimate aim of the International Academy of Astronautics working group on the IGMASS project should be the concrete proposal concerning the creation of the IGMASS on the base of efficient development and joint use of aerospace capability and advanced technologies, based on wide-ranging international cooperation.

The potential member-states of the project are Russia, the USA, Canada, EU, Japan, China, India, Indonesia, Australia, other countries of Asian-Pacific region, Africa, South and Central America. For the participation from the very beginning of the IGMASS Project implementation the countries which territories are the most prone to major natural disasters (earthquakes, tsunamis, floods) and thus interested in the well-timed prediction of these events should be involved.

Organizational forms of the IGMASS project management during its realization may be the International Coordinating Council, the Management Company or the International IGMASS Consortium. [24]

[24] The head company or an International consortium legalized as a special agreement, a temporary association of independent business and government agencies for the realization of major international project, colocation of industrial orders, conducting industrial large-scale credit, financial and marketing operations, and coordination of activity to obtain benefitial contracts and their joint performance.

The prototype of the International Coordinating Council is created by the decision of the Cyprus «Symposium on Space and Global Security of Humanity» so-called «The International Public Committee on the Project IGMASS realization», which includes heads of several national space agencies, rocket industry and space industry leaders, outstanding scientists and administrators, as well as dedicated specialists and politicians of more than twenty countries of the world.

The founders of the Project Management Company or the IGMASS Consortium may be governments of its member-states (represented by the relevant ministries and departments), the international and national academies of astronautics, cosmonautics various international and national financial funds, space agencies and departments of the project member-states, specialized russian and foreign companies with state, joint and private capital, corporations and individuals. Thus, the IGMASS Consortium could effectively meet the challenges of organizational and technical, legal and financial aspects of the project, the effective coordination of the system creation works/[25]

During the realization of the Project IGMASS we will reach the understanding of goals, objectives and key limits of the project based on:

- ✓ performed research on the IGMASS creation conceptual issues (Academy of Cosmonautics n. a. K.E. Tsiolkovsky jointly with the Space Systems Research Institute in 2009 held iindependante research on IGMASS agenda to define its technical profile and operational perfomance, the results of which are five books, toincluding more then one thousand pages);
- ✓ adoption of the IGMASS Conception, determination of the principles and conditions of the Project realization as well as political, legal, financial and economic limits, risks and threats of internal and external nature (the Second International Specialized Symposium is to be held in July 2010 in Riga, Latvia to discuss these issues);
- ✓ negotiation of authority and responsibility of project manager, its main participants, performers and procedures of organizational work.

At the initial stage of the project realization should be carried out preliminary technical and economical system study, also nessesary to take concrete steps to create a legal project and its governing body, to make international patents on IGMASS and its constituent parts, to determine cooperation of relevant enterprises and organizations - participants of the project, to find the UN institutions interested in supporting and promoting IGMASS at the United Nations level.

Among the priority activities at the initial phase of the project IGMASS realization is an integrated scientific research experimental work on the challenges of system creation that includes the development of principles and methods for precursors of potentially dangerous parametric geophysical phenomena; appropriate situation models to assess their development in time and space, the development of mathematical, logical and software processing models of predictive monitoring information. The Ordering customer of such a comprehensive research engineering can become the International Academy of Astronautics, and it is useful to attract for its performance leading research organizations, enterprises and research institutions of the project member-states. Based on the results of this research engineering should be developed technical requirements for development project of IGMASS creation, which will be the initial phase of the project realization: draft design system, the creation of experimental models of its main elements and working documents on the experimental products of the system (2011-2013); manufacturing of advanced system products, autonomic testing and adjustment of working documents (2012-2013); complex and exploratory testing and adjustment of working documents (2015); the beginning of flight tests, preparation of

[25] The basis of IGMASS Consortium consists of: suppliers of space products and services, corporate users, research institutes, universities and research labs, interested government agencies of various countries. Consortium members send technical experts and representatives to attend its various groups: these groups will conduct major technical work of the Consortium - the result of their activities are technical reports on various aspects of creating and using the system, sub-projects, software tools with open access to various monitoring products and services.

the documents for system products, their serial production, system commissioning (2016); the beginning of the system full-scale expansion (2017).

The current observable changes in the methods of state administration, related to prevention of dangerous processes and phenomena, initially determine the economic and «managment» efficiency measures for practical realization of the IGMASS project by the world community.

VIII. GENERAL ESTIMATION OF EXPENCES ON THE PROJECT REALIZATION

The sources of funds of the IGMASS project are share capital of the Consortium authority (in case of its creation), loans from international and domestic commercial banks (in case of the decision of system creation), and then - funding for services to provide monitoring and forecasting information to state and commercial organizations, with the start of the system and its components operation. The financial resources of the Project will be formed from its own (share) capital, borrowed funds and retained earnings from the transactions. Shares of the Consortium can be distributed among the states, wishing to participate in the IGMASS project. On the part of the project member-states half of investment is public in the form of the system ground equipment (spread of equipment to provide and operate aerospace facilities, etc.), and the rest part is private investment in this project. Subscribtion of the interested countries for Consortium shares will be realized in accordance with their economic power following the example of the World Bank.

The following estimates for the IGMASS project realization have been derived from the prefeasibility development and creation cost study of megasystems, which required large investments at the national and international levels. Inasmuch as the technical configuration of IGMASS is at the early stage of development, it is difficult to give comprehensive figures for the realization cost of the system lifecycle, starting with Research and Advanced Development and ending with tests and deployment of complex technical and organizational rates of ground, air and space segments. Meanwhile, the estimates indicate a figure up to 6 billion dollars of the USA in 2009 including the cost of bringing information resources and infrastructure components of potential participating countries. The share of specially created IGMASS space segment of the first stage (without the warning system of the asteroid danger), made up of 16-20 spacecrafts will be about 10% of this amount.

Certainly, these figures in the septenary of the project realization will be distributed differently. In case of their consideration in the prospect of financial activity for the International Consortium project, as well as expanding the number of participants, one may talk about its profitability both in terms of direct financial investment and long-term investments for the rocket and space industries development of the member-states of the Project. Moreover, the beginning of the IGMASS creation in the wide international cooperation and under the guidance of the UN, as well as the subsequent operation of the system will be characterized by a pronounced effect of socio-political, humanitarian and economic nature.

Socio-political significance of the IGMASS project will be understanding by the international community of the necessity for peaceful uses of outer space and integrating efforts to solve global problems of the XXI century, the strengthening of the foreign policy positions of the member-states in prevention of the scientific, technical and political surprises related to parry threats and risks of today's multipolar world.

The humanitarian effect of the practical realization of this international Project includes both health and life preservation of hundreds of thousands of people with the help of permanent control and forecast of natural and man-caused disasters, early warning the population about natural disasters and global calamities, rendering timely medical assistance in case of their occurrence and adverse development and finally - the possibility of developing and realization of effective measures to parry the natural and man-caused threats across the spectrum of possible approaches by the world community.

The economic aspect of the IGMASS project realization is directly or indirectly positioned as retention and buildup of scientific, engineering and technological capability of participant-states (the possibility of creating thousands of new jobs in the rocket and space industry), annual saving financial and material resources in the amount of several millions dollars of the USA by mitigation of the negative impact caused by natural and man-caused disasters. Direct economic effect by IGMASS using will also consists of the profits from the sale of monitoring information and services to consumers and commercial resource management of distant education and telemedicine. A commercial sale of packages of distant education programs, increased investment through the expansion of public funding and attracting private investors, etc can be considered as an examples.

Considering the challenges, threats and risks, with which the Humanity enters the post-industrial phase of civilization development, it is impossible to overestimate the importance of major international projects focused on recieving and expansion of information, which turned into economic and political categories, defines all types both national and planetary resources .