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CONCEPTION OF INTERNATIONAL GLOBAL MONITORING AEROSPACE SYSTEMS (IGMASS)

(DRAFT)

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INTRODUCTION

This document - the Concept of International Global Monitoring Aerospace System[1] (IGMASS) as a system for predicting 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 and navigation and telecommunication resources of the Earth for the benefit of all humanity - is 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 they were reported at international scientific forums «Space for Humanity» (Korolev, Russia, 2008), «Future 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 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 creating IGMASS. 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 held in November 2009 in Limassol (Cyprus Republic) of the First International Specialized Symposium on «Space and Global Security of Humanity».

The Concept includes the goals of creating IGMASS, tasks that are expected to solve with its help, form of the system, description of its functionality, including receiving, processing and dissemination of forecast data of aerospace monitoring, use of information resource of 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 Concept includes textual and illustrative parts that give an idea 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 ISSUES

Sustainable development of modern civilization is prevented by set of threats of natural and man-caused nature, requiring the adoption of effective preventive measures to 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, volcanoes, tsunamis, landslides, mudflows, 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 location of complex technical systems 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

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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 treated natural and technological disasters, is about 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.

frequent instances of crossing Earth's orbit with the trajectories of large but often unknown asteroids, 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 satellite vehicles are used for basic research of solar-terrestrial relations, but the observations of the Sun from space are conducted just periodically. The number limits monitoring of outer space in order to detect Earth-threatening comets and asteroids and physical abilities of ground-based optical and radio telescopes [5]. Nowadays less than a half of two thousand of these cosmic «wanderers» is listed. Even the most powerful space telescope Hubble is able to detect 1 km size asteroid at a distance of not more than 40 million miles (or 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 practically impossible. With the current development level 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 million 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. 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 use of both existing and prospective ground-based, air and space facilities.</u>

[5] Maximum detection range with the help of ground-based asteroids with a transverse dimension of not less than 1 km does not exceed 2-2,5 million km. It means that at an average closing rate of the asteroid with the Earth (20 km / s) and the collision can occur in less than 1,5 days, that is quite insufficient to make any effective security measures.

Concerted international efforts in this direction have been taken from the very beginning of the space age. International global space system for hydrometeorological service (the project "Global Climate Observation System") has been established and operates, it is able to predict coming disasters of meteorological origin and dangerous climatic anomalies (floods, typhoons, hurricanes, storms, forest and grass fires, droughts, etc.). Today, there are space systems, which together are capable of solving up to 300 basic and applied problems of remote sensing (RS), including tasks of assessing the impact of emergency situations of natural and technogenic nature. However, the tool structure, size and structure of RS satellite vehicle groupings do not allow to solve the problem of forecasting and early warning of coming danger[6].

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 tasks.

The Project executon in case of its practical realization 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 Earth.

[6] 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 "Iono-sat"(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 high attention to the development of space systems of monitoring emergency situations. During more than five decades since the launch of the first satellite, have been developed several generations of spacecrafts and target and communication equipment, new multispectral and hyperspectral devices, multispectral radiometers and radars, lasers, heliogeophysical equipment, computing, communication means and many other things. New technical and technological solutions have been passed flying work for the small and micro-satellite vehicles. [7] As a result, modern observation satellites, with mass from 300 to 800 kg effectively solve the problem of monitoring the atmosphere and the Earth's surface. Due to reducing weight and cost of spacecraft it has become possible to create multi-satellite systems, providing high efficiency, reliability and integrity of monitoring of the various objects and processes.

The relevant projects and initiatives in various stages of realization are carried today by the United States of America, Canada, EU countries, the states of South and Southeast Asia. Both national and corporate space systems of monitoring and security are developing, which include multipurpose multi-satellite space remote sensing, communication and data broadcast, navigation, hydro-meteorological 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, in which creation take part almost all the leading nations of the world (the USA, Canada, France, Italy, Germany, UK, Israel ,India, China, Russia and Japan), international consortia and about 20 countries from all the continents of the Earth[8].

Means of space monitoring are accepted relatively to divide into meteorological systems and remote sensing systems; although during the solution of the applied tasks of monitoring we use all-up information from both systems. Hydrometeorological sys-

[7] 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.

[8] 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).

tems are usually deployed in low polar geosynchronous[9] and geostationary[10] orbits, providing a meteorological monitoring and forecast of dangerous meteo-phenomena, only partially can be used to meet the challenges of monitoring taking place in the lithosphere of the geophysical processes. Set on newly launched low-orbit meteorological satellite vehicles geophysical tools can record in the atmosphere and ionosphere only some of precursors of large earthquakes and heliophysical anomalies.

Space remote-sensing means are now represented by very extensive nomenclature of space vehicle: 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-In, 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); Russia n (Resurs DK). Algeria, Brazil, Nigeria, Taiwan, Thailand, Turkey, South Korea and several other countries also have their own observation satellites from space, created in cooperation of leading space powers.

IGMASS as a supranational system is proposed to create according to the principles of using all the potential of modern space technology 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 solving of the tasks of identifying the harmful effects of natural disasters and emergencies. Thus, the final result of an initiative of the United States «Group on Earth Observations» (GEO) based on a 10-year Plan (2005-2015) the international project Global Earth Observation System of Systems (GEOSS) will become publicly available global infrastructure, which should in scale of near-real time provide a wide range of users a comprehensive, processed information of space monitoring[11]. Though due to the investment of recent years it has become possible within GEOSS to unite disparate monitoring tools and software to measure and pre-

[9] 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

[10] 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

[11] 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 grouping «NAVSTAR», a powerful package for modeling, simulating and forecasting, as well as means for early warning of the population in countries and regions at risk.

dict the physical, chemical and biological parameters that characterize the integrated occurring on the Earth potentially dangerous processes, this project is not intended to create its own orbital grouping that significantly limits the ability of solving the declared tasks of prediction of dangerous natural and man-caused phenomena.

International system of space monitoring of natural disasters (Disaster Monitoring Constellation - DMC), for realization of which in 2002 was created an International Consortium (Algeria, Britain, Nigeria, China, Thailand and Turkey), has a low-orbit grouping in polar orbits of seven national British-developed 80-130 kg microsatellites, equipped with multispectral optoelectronic complex of medium resolution of 20-30 m. Micro-satellites 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 is very limited - it can record only bypast major seismic or man-caused phenomena, it focuses on obtaining information only in the visible spectral range and is designed to provide information quickly 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 functionally should include space remote sensing, 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 grouping. Although some parts of the system are already in operation, it is still under development and completion of the formation of the orbital grouping is planned for 2012[12].

The orbital grouping GMES includes 13 observation spacecrafts, including satellite Gelios-2, Pleiades, Cosmo-Skymed, SAR-Lupe, Spot-5, Rapid Eye, DMC2 (Topsat 2) and TerraSAR-X[13.] In future, ESA is planning to create a set of satellites (among them - KA 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 me-

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

[13] 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 SC), as a part of the grouping GMES in some periods can operate for more than 70 spacecraft.

dium spatial resolution (for mapping and hyperspectral shooting), optical equipment and a radar altimeter (for detailed monitoring of ocean waters, the Earth's atmosphere with low and geostationary orbits). Although the GMES project has its own orbital grouping, development and acquisition of satellites for which, as well as the coordination of space-based assets of European national satellite operators, but it does not include tasks 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 their resources are unlikely to be attracted regularly in the interest of the 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, Canada, India, USA, Russia and Japan, aims to create a unified system of space data, designed to provide the necessary information to victims of natural or man-caused disasters. Although the orbital segment of the project includes national spacecrafts 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 the event 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 problems of occurring natural disasters on the planet.

The project «Sentinel Asia», proposed in 2004, which includes 51 organizations, as well as 44 agencies from 18 countries, provides for the establishment in the Asia-Pacific region (APR) system of control and liquidation of natural disasters through the use of opportunities of space technology remote sensing in a real-time mode, in conjunction with GIS-mapping technology and modern global network “Internet”[14]. However, considering the limited size of the onboard equipment using in the project and the specifics of the spacecraft orbital construction groupings, the solving of predicting 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 systems of monitoring emergency situations and their objective focus, we should note the complete absence among the problems solved with their use, such as preven-

[14] 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.

tion of global planetary threats (related to the meteoroid, asteroid danger, solar activity, etc.)

III. AIM OF IGMASS CREATION AND PROBLEM SOLVING WITH ITS USING

International Global Monitoring Aerospace System (IGMASS) is being created to provide well-timed warning of the international community about coming disasters and emergencies, natural and man-caused disasters through a global and operational 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 to solve the humanitarian problems of Humanity.

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

At the same time using ground, air and space facilities of the system the following objectives will be solved:

- ✓ 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 technological processes;
- ✓ collection, primary processing on board of the spacecraft and transfer of monitoring data to the earth receiving space information stations;
- ✓ generalization and complex processing in the national, regional and international crisis centers of the global monitoring data received from space, air and earth assets, its interpretation, storage and display;
- ✓ prompt 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, preservation of cultural values, development of distance education and training in various fields;

✓ 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 IGMASS, the priorities of the system should be to identify earthquake areas, detecting and documenting the precursors of dangerous geological phenomena for future prompt warning of their coming, the evolution in time and space, and the subsequent permanent control of environment danger (seismic, aggressiveness, variability, etc.) on man-caused systems and its components[15].

Appreciating the necessity of optimizing the terms of IGMASS creation, other problems, assigned to the system, will be solved in two stages. The first stage - telecommunication and navigation support activitivities for disaster management, human operations, development of distance education and training in various fields. The second stage - long-term objectives of preventing global threats in and from outer space and the gradual formation of a 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 space that can be achieved by a combination of several groupings of spacecrafts to be placed in the low and geostationary orbits, equipped with specialized on-board facilities, combined with the target aircraft facilities and means of earth radar control and effective earth infrastructure for receiving, processing and analysis of information.

IGMASS is based on the following basic principles:

✓ absolute observance of the norms and principles of international space law, as well as the relevant single and multi-state responsibilities in the field of space activities;

[15] 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 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 earth infrastructure system based on full scale working out (testing practice) basic technologies and software and hardware tools of aerospace monitoring prediction;

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

Based on the purpose and tasks IGMASS must meet three basic system requirements. **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 areas and development with preliminary assessment of impacts on the basis of ecosystems and human populations in order to develop adequate measures of prevention and protection.[16] The following should be provided:

✓ search, identification and recording of earthquake-prone regions, active faults, updating of the global map of seismic dangers, including the precise mapping and identification of signs of such activation[17];

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

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

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[16] 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 nature, the long-term forecast - global natural disasters of geological nature.

[17] 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 the emergence of large-scale irregularities in the F2 layer of the ionosphere, and ultra-high-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.

- ✓ continuous monitoring of the development of seismic phenomena, fixing their devastating effects on a real-time scale;
- ✓ mapping areas for construction of objects of potentially dangerous industries, monitoring the progress of construction of these objects;
- ✓ monitoring the impact of geotechnical processes in the largest and most dangerous man-caused objects and systems, as well as their environment;
- ✓ warning of oncoming weather, seismic, hydrological, geomagnetic and other dangerous phenomena threaten the technical objects, and other unauthorized interference in their work;
- ✓ monitoring the solar activity, the gravitational effects anomalies of the Moon and the Sun in order to predict the effects of geomagnetic situation;

control of the near-Earth space for the prevention of the meteoroid and asteroid threat [18].

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

Thirdly, to provide a wide range of consumer with high-definition navigational and telecommunication services for monitoring progress in dealing with emergencies, conducting evacuation activities, moving people and goods, and solving other social and economic problems (distance education with using advanced space and information technology, medicine disasters, training of relevant experts of IGMASS, specialists in other fields of science and technology).

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 - grouping of microsatellites with onboard hardware detection of early signs of destructive disaster, both existing and future national and international air and ground-based including contact and remote sensors, remote sensing space systems, communication

18 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.

and broadcasting of meteorological and navigational support (or allocated information and logistical resources), together with appropriate ground infrastructure of management and maintenance of spacecraft, receiving, processing and expansion of monitoring information. This will provide a global perspective, the complexity of emergence monitoring and development of dangerous phenomena occurring on the Earth and in near-Earth space, reliable prediction of their occurrence in the world community to take the necessary measures to prevent or mitigate the devastating impact, well-timed evacuation of people, the safest material resources and cultural values, along with extensive use of navigation, telecommunication and information resources of the world community to solve the entire range of contemporary problems of Humanity.

Own orbital grouping of IGMASS 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 warning of global dangerous geophysical and meteorological phenomena and efficient data transfer to monitor their precursors to almost anywhere in the world.

Space and aircraft facilities of 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 prediction of adverse climatic and weather conditions, seismic disturbances (crustal movements, landslides and rockfall), caves, mudflows, avalanches, etc.) that may threaten the integrity of technical facilities. Self-importance will have the task of recording all kinds of anomalies allowed in the construction and operation of the objects (emissions to air or water, poisonous, radioactive materials, flammable gases, dust, aerosols, etc., unauthorized access to pipelines, disruptions in transport infrustructure, etc.)

Ground-based component of IGMASS must provide collection from space-based and aircraft facilities of objective, telemetry and navigation information, the deployment and replenishment of the space echelon of IGMASS using space-rocket complexes on earth, sea and air bases.

Specially created (own) space segment of IGMASS will consist of low- and high-orbit grouping of micro-satellites, placed respectively in the areas of low, sun-synchronous (polar) orbits and the GSO. On low orbits would be deployed sattelites equipped with standardized means of monitoring and specialized geophysical equipment (side-looking radar and interferometry, multifrequency, polarimetric and multistation radar with antennas with synthesized aperture). In the area of the geostationary orbit will be available standardized microsatellite platforms for solving heliophysical observation, experimentation with advanced scientific equipment, as well as communication and broadcasting. Developments, such as those that would be required to create a low-orbit observations sattelites 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 U.S.A. and several European countries.

Attracted by a specially created (own) national and international space segment of IGMASS facilities - geosynchronous and low-orbit space complexes and systems of hydrometeorological support, remote sensing, communication and broadcasting ground-based receiving complexes, recording and processing of space monitoring information will provide an integrated picture of precursors of natural and technological disasters.

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

- ✓ means of geophysical monitoring of solar activity and the identification of physical abnormalities of the Earth's magnetosphere, ionosphere, atmosphere and lithosphere;
- ✓ radar X, L and P-range with multiple polarizations;
- ✓ microwave radiometers (from 10 to 200 GHz and more) for the registration of small gases in temperature, humidity and other atmospheric parameters;
- ✓ optico-electronic devices with high and medium spatial and radiometric resolution to capture images scale from 1:20000 to 1:500 and recording the Earth's surface temperature;
- ✓ facilities of radio-tomography of the ionosphere using signals of low-orbit navigation satellites and ground receiving stations;
- ✓ heliophysical equipment for the registration of anomalies of solar activity;
- ✓ powerful optical telescopes to monitor the asteroid and meteoroid threat [19] and the efficient warning about the dangers of «space debris».

[19] 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).

Air segment of IGMASS is expected to make of the detachments of national aircrafts (airplanes, helicopters, airship, meteo-sounding balloon, pilotless vehicles), used by the project member-states. Extensively investigated in recent years pilotless vehicles systems of remote sensing can take in the air segment of IGMASS an important place, especially in solving problems of predicting large-scale man-caused disasters.

Ground segment of IGMASS will include a range of launch vehicles, facilities management subsystem for monitoring consumer information special complex of navigational information subsystem of IGMASS.

The set of insertion vehicles of IGMASS should provide a single, passing and the associated insertion of small and micro-satellites 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 IGMASS should guarantee the collection of coming from the satellite in its own orbital system segment of the telemetry data, conducting sessions management, developing long-term and operational plans for special applications of orbital groupings of the work programs of corrective commands of onboard equipment, etc.

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

The upper level of the subsystem will include international crisis management centers that appear in Russia, Asia, Europe and America. The average level of the hierarchy of the subsystem is presented in the form of national control centers in crisis situations, reliably connected with the centers of the upper level. Lower level of the subsystem will consist of ground sensor stations collecting data from ground and air facilities, as well as the reception of space monitoring information of national and international affiliation. For the effective functioning of IGMASS we will need to deploy at least five similar stations with international status, spread across the globe. In the interest of direct support of national data 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 navigational and information subsystem within IGMASS is intended to create a unified navigation and information space within which, for an unlimited number of mobile and stationary objects will be possible to determine automatically the precise location coordinates according to the signals of satellite navigation systems GLONASS / GPS NAVSTAR / Galileo. The structure of ground special complex will include "integrated telematic system of transport corridors" for evacuation activities in case of natural disasters, increase the capacity of the road network, traffic safety, environmental protection, improving the movement of people and goods.

Important independent lines of information and telecommunication resources of IGMASS will become distance education system 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 medical assistance in case of natural and technological disasters.

VI. PARTICIPANTS AND STAGES OF IGMASS PROJECT REALIZATION

Considering the fact that the problem of predicting global natural and man-caused phenomena has a pronounced international nature, and taking into account the necessity to solve during the creation of IGMASS a set of complex scientific, technical, organizational and applied problems related with the development, testing and using the latest equipment, as the first steps towards the promotion of the Project of a system it seems appropriate to take the following organizational steps.

1. To provide the Project IGMASS with strong organizational, political and perhaps financial assistance at the UN level, which will be necessary for its future realization.

2. To promote the Project IGMASS at the interstate level with the help of the International Academy of Astronautics as an organization, accumulating world scientific resources in the field of space research for the benefit of all humanity.

3. To define the final goal of research of special Working Group of the International Academy of Astronautics on IGMASS specific proposals for the creation of a system based on the effective development and shared use of aerospace resources and advanced technologies, based on wide-ranging international cooperation.

The Project member-states list may include Russia, the USA, Canada, EU, Japan, China, India, Indonesia, Australia, a number of states of Asia-Pacific region, Africa, South and Central America. For the participation from the beginning in the Project IGMASS realization should be involved 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.

Organizational forms of the project management of IGMASS during its realization may be the International Coordinating Council, the Management Company or the International IGMASS Consortium. [20]

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 «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 around the world.

<u>The founders of the Project Management Company or IGMASS Consortium</u> may be governments of its member-states (represented by the relevant ministries and departments), international and national Academy of Astronautics, various international and national financial funds, space agencies and departments of the project member-states, specialized russian and foreign companies with public, mixed and private capital, corporations and individuals. Thus, IGMASS Consortium could effec-

[20] 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, large-scale credit, financial and marketing operations, and coordination of activity to obtain benefitial contracts and their joint performance.

tively meet the challenges of organizational and technical, legal and financial aspects of the project, the effective coordination of work on a system creation.[21]

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 conceptual issues in IGMASS realization (Academy of Cosmonautics n. a. K.E. Tsiolkovsky in conjunction with the Research Institute in 2009 was conducted the research on determining of IGMASS shape and organization of its functioning, the results of which are five volumes, totaling over a thousand pages);

✓ adoption of the IGMASS Concept, determination of the principles and conditions of the Project, political, legal, financial and economic limits, risks and threats of internal and external nature (so far 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, organizational work.

At the initial stage of the project realization should be carried out preliminary study system, 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 is an integrated engine research and experimental work on the challenges of creating a system that includes the development of principles and methods for early warning 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. Customer of such a comprehensive system may become the International Academy of Astro-

[21] The basis of IGMASS Consortium is its members: 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, open access to various monitoring products and services.

nautics, and it is useful to to attract leading research organizations, enterprises and research institutions of the project member-states. The result of this research should be development of Terms of Reference for IGMASS Establishing, which will be the initial phase of the project realization: draft design system, the creation of experimental models of its key elements and working documents on the experimental product system (2011-2013); manufacturing of advanced system products, autonomic testing and adjustment of working documents (2012-2013); complex testing and adjustment of working documents (2015); the beginning of flight tests, preparation of the documents for products of their serial production, putting the system into operation (2016); beginning of the system full-scale expansion (2017).

The current observed changes in the methods of government authority, associated with the shifting from reaction to prevention of dangerous processes and phenomena, initially determine the economic and managing efficiency measures for practical realization of the Project IGMASS with the help of the world community.

VII. GENERAL ESTIMATION OF EXPENCES ON THE PROJECT REALIZATION

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

The following estimates for the Project IGMASS have been derived from the preliminary analysis of development costs and the creation of mega-systems that require large investments at the national and international levels. Since the technical configuration of IGMASS is at the early stage of development, it is difficult to give comprehensive figures of the cost for realization of the system lifecycle, starting with research and ending with testing and deployment of complex technical and organizational relationships of ground, air and space segments. Meanwhile, the estimates indicate a figure up to 2 billion U.S. dollars in 2009 including the cost of bringing information resources and infrastructure components of potential participating countries. The share of specially created space segment of IGMASS of the first stage (without the warning system of the asteroid danger), consisting of 16-20 spacecrafts will be about 10% of this amount.

Certainly, these figures in seven-year period of the Project realization will be distributed differently. If we consider them in light of the prospect of financial activity generated by the Project of an international Consortium, as well as expanding the number of participants, we can talk about its profitability, both in terms of direct and long-term investments in the development of rocket and space industries of the member-states of the Project. Moreover, the beginning of the creation IGMASS in 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 Project IGMASS will be the understanding by the international community the necessity for peaceful uses of outer space and the association on this basis, 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 is to preserve life and health of hundreds thousand of people from the operational forecasting of natural dangers and man-caused situations, well-timed warning people about natural disasters and global catastrophes, providing timely medical assistance in case of their occurrence 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 global community.

The economic aspect of the project IGMASS realization directly or indirectly appears through the preservation and reinforcement of the scientific, technological, scientific and technical capacity of the Project member-states (the possibility of creating thousands of new jobs in the missile and space industry), annual savings of financial and other material resources in the amount of several million dollars by reducing the negative effects of natural and man-caused situations. Direct economic effect from using IGMASS will also consist of the profits from the sale of monitoring information and services to consumers and commercial opportunities of distance education and telemedicine. As examples can be considered a commercial sale of packages of distance education programs, increased investment through the expansion of public funding and attracting private investors, etc.

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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 the recieving and expansion of information, which turned into economic and political category, defines all types both national and planetary resources .