DUAL USE of TECHNOLOGIES

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1. Introduction

One characteristic of today's society is the existence of dynamic structures with rapid transformations with constant character, for which the necessary time for making decisions has been enormously compressed, the succession turning into simultaneity. In this context, it is normal and desirable to have a large transfer of technology from the areas in which, by massive investments specific to defense, nuclear, and aerospace technologies, important achievements have been obtained, and the boundaries of knowledge have been exceeded.

Within this approach, the concept of dual use of technologies has been imposed, which actually represents the transfer of knowledge and applications from exclusive fields previously specified in the civil field, in order to improve the natural environment of man, to preserve it, to create conditions for the effective release of the human being from physical or intellectual constraints imposed by the man-nature relationship.

The big challenges that mankind has to face are the consequences of phenomena like natural, material and energy resource exhaustion, uncontrolled environmental pollution, population growth, with consequences on the possibilities to ensure an adequate food supply.

In this context, of a real interest because of its amplitude and effects is the monitoring and management of some processes, at the regional and global scale, with major influences upon environmental imbalance, using satellite technologies, information technologies, the amazing development of the communication capacity.

Contemporary technology cannot ensure the necessary conditions for sustainable development if it destroys the society assets the eco-sphere depends on, and at the same time demands permanent consideration for its advantages to be balanced with its ecological value.

It is about that mild technology specific to the mentioned fields, characterized by:

- Risk-free applications for human health and survival;
- Continuous renewal of the products from the constructive, functional and qualitative point of view;
- Pre-eminent utilization of the natural substances;
- Reduction of consumption of raw materials, materials, and energy.

Technology transfer for the benefit of the civil society can be activated by increasing the technology spread ratio, increasing technological substitution ratio, the frequency of applied technological innovations and decrease the temporal disparity between the innovation appearance and its application.

Technology transfer leads to the elimination or decrease of unwanted effects related to the transition from general theory to applications, elimination of the degree of uncertainty in scientific research, decrease of technology development costs, elimination by political action and intervention of specialized authorities, of objectionable aspects of physics laws application, etc.

Next, some aspects of the dual use of the teledetection and SCADA systems technology, as well as global positioning technologies using satellite technology will be analyzed.

2. Teledetection and telemetry

Teledetection, i.e., remote measuring, recording, storing, and evaluation of some parameters in dynamic evolution, has registered spectacular development with applications in the majority of man-nature relations activities: geology, agriculture and forestry, hydrology and meteorology, oceanography, geodesy and cartography, land improvement, geodynamics, and environment protection.

Teledetection has been developed in the defense field, in order to discover, identify, classify and destroy, using different spectra (e.g. infrared, visible, radar), fixed or mobile enemy targets.

Telemetry is the technique utilized to send and receive remotely data and information about the natural or anthropic environment. The data are sent to one or more locations, by phone cable, radio, microwaves, or other means. The communications methods towards certain locations, as well as the information protection procedures, are incorporated into the system.

From the brief presentation of the fields of human activity where detection can contribute in a decisive way, the tremendous interest in improving these technologies is demonstrated, an interest materialized in the developed countries in massive investments, very efficient economically and rapidly redeemable.

An important application of teledetection and telemetry is related to the management of natural and anthropic risks that, most of the time, have as effects huge material losses as a consequence the destruction of infrastructure elements, doubled by human losses.

Natural hazards such as earthquakes, volcano eruptions, hurricanes, tornados, tsunamis, floods, land slides, droughts, etc., and those provoked by human activities, e.g. chemical pollution, radioactive pollution, fires, dam damage, are inevitable and with a high rate of occurrence.

The effects of natural disasters last for a long time after the causing event occurred and, varying with the social organization and its early warning, prevention, and containment means, they can be minimized. The global population growth, excessive urbanization, environmental decay, and technical progress create new disaster vulnerabilities, the associated costs rise continuously and at an alarming rate.

The issue of mitigating disaster effects belongs to the central and local administration; they should take steps in order to rapidly and correctly analyze the teledetection information, using adequate software programs.

Specialized satellites LANSAT, SPPOT, ERS, OrbView, CARTERRA type send data/images provided by the recording devices on-board using, *inter alia*, SAR type technologies (Synthetic Aperture Radar) by which relief, tridimensional, detailed and accurate maps can be realized.

Very small modifications (centimeter scale) of the information regarding terrain can be detected by the differential analysis method.

The satellite data are useful to monitor emergencies, identify the risk area, and evaluate the extent of a disaster. Full picture of the situation of large areas, with the indication of danger and affected zones can be obtained within a short time. The data collected after the disaster can be utilized to estimate the damage, for cartography purposes, and to design reconstruction and prevention plans for the future.

The image resolution of the satellites for civil application is on the order of meters in comparison with those for military application which is on the order of centimeters.

Similar to cartography, the high resolution image can provide information regarding the total and accurate inventory of the affected goods, evaluate the vulnerabilities, and determine the possibilities to assist the population: evacuation ways, accommodation, medical assistance, management of transportation means.

In land surveillance it is mandatory to use multispectral sensors which collect data in more spectral bands, from visible to infrared, as well as radar spectra, which are useful especially when there is fog, rain, or clouds.

The possibilities of capitalization of the space surveillance of the earth and the application of teledetection to solve the major problems of the human communities, and more, are apparent.

The introduction of these technologies requires high costs related to the fact that each application has its own particular software and hardware. Without entering into details, although the approach is similar, for instance, the application for flood surveillance is different from the application for monitoring forest fires, or chemical, radioactive pollution, and so on.

The high initial costs of civil applications of space technologies are paid off by major influences on the economic contribution they could have with regard to disaster warning, and decrease their number, by planning the means and long-term economic activities, urban development, land reconstruction development, monitoring environmental pollution, and location evaluation.

From the basic analysis of the material and human costs consequent to a disaster in comparison with the application of efficient warning-monitoring systems, by using teledetection technologies the economic efficiency of these systems can be inferred.

It is necessary that the entire society, including the political decision makers, be informed with regard to these aspects and the necessary procedures be ordered and adjusted by rigorous and realistic plans.

In the teledetection application case, besides the investments for producing and placing into orbit the surveillance satellites, it is necessary to have ground stations for receiving and processing the information from the satellite, equipment and communication channels, computerized technique and software programs for analyzing and interpreting the information; investments are necessary to create an information system dedicated to teledetection information transmission previously processed at the end-users, and back-up equipment.

Despite the high initial costs, efforts should be made not only because of the huge economic benefits, but also because without these technologies our country would be lag behind other EU states which put a lot of efforts in this field. On the other hand, these systems are integrated at the regional or global level, and each state should bring its own contribution.

For monitoring emergencies, the following space, functional, teledetection, telemetry, and communication systems are successfully utilized:

- Geostationary systems (INMARSAT, EUTELSAT, INTELSAT); the facilities of communication with satellites from the system are ensured by BGAN type equipment which ensures from office services to voice communications, big folder transfers or even video conferences. The maximum transfer speed starts at 144 Kb/s and it can reach 492 Kb/s.
- Daytime orbit systems (INTERSPUTTNIK, Molnia, Orbital);
- Communication satellites with low orbit (GLOBALSTAR, IRIDIUM);
- Communication satellites placed on geostationary obits (Thuraya system).

The IRIDIUM system, for which there is a communication application in our country, too, consists of 66 interconnected satellites orbiting at a height of 800 km. The system enables any type of telephone transmission between any geographical places on the earth. The satellite launches started in the spring of 1997, and the system became operational one year later.

The Thuraya system offers GSM and GPS satellite service through a single phone terminal, dual mode and user-friendly. The phone configuration enables voice, fax, SMS, rapid data transfer services.

Thuraya was founded in the Arab Emirates in 1997 by a consortium formed of the market leaders of telecommunication operators and international investment companies. The main contractor hired to build the satellites was the American company Boeing Satellite Systems, also known as Hughes. The three satellites of the system are placed in geostationary position at about 36,000 km distance from the earth.

The first Thuraya satellite was launched on a Sea Launch Zenit – 3SL rocket, from the Equator, in the middle of the Pacific Ocean, on 21st of October, 2000. The launch broke a record too, because it was the first satellite launched from the Middle East ever, and the heaviest one ever launched.

The second satellite was launched into orbit on 10th of June, 2003, by Sea Launch which was the launching vehicle for the first satellite, too. Designed for an average life span of 12-15 years, the second satellite is positioned at 25,786 km (22,236 miles) above the earth at 44 degrees east longitude and 6.3 degrees declivity.

The third Thuraya satellite weighing 5,173 kg, was built by Boeing Satellite Systems and launched on January 15th, 2009 from the Odyssey platform at 154 West longitude, being placed into orbit by a Zenith-3SL rocket. The third satellite contributes to the system extension of a covering capacity which now represents approximately 90% of the earth's surface.

These types of systems are recommended to be used within emergency communication nets, *inter alia* due to the reduced costs and radio visibility that is almost global.

Within the hazard monitoring operations, the Global Positioning Systems (GPS) and the Global Navigating Systems (GNNS) are very important, too.

There are two operational global positioning systems, i.e., GPS – NAVSTAR (SUA) and GLONASS–COSMOS (Russia).

Both systems are utilized to monitor air and land transportation, for time synchronization, monitoring of ecological nature, search and rescue operations.

At the European Community level, the technical activities necessary to launch the European Positioning System GALILEO are already initiated.

The elaboration of a unitary and coherent policy is required at the national level, by the legislative and executive powers, which will offer the possibility to realize and to administrate a teledetection system compatible with the existing European systems, and which will enable the capitalization of the obtained information by making them available to the private or governmental entities, and the central and local administration.

One application with tremendous economic and social implications, the urban cadastre, is worth emphasizing. Its costs can be paid off within very short time as a result of property regimen clarification, or getting the necessary approval for constructions both for rural and urban environment.

Processing the elements provided by teledetection and telemetry is made through SCADA systems (Supervising Control and Data Acquisition) which collect the information, transfer them to an analysis and control unit, and display the results on the operators' screens.

SCADA systems can be utilized to monitor and control industrial capacities or technological processes.

The control and monitoring system is distinctive for researching the information collected by sensors, and then for generating the necessary operations for each event. This system might have only one computer in its configuration, or might be a network of terminals allowing information distribution to the specific end-users.

The civil applications of teledetection and SCADA systems are very diverse especially in the energy field, fluid management (drinkable water, fuels, residual water), transportation, building monitoring, crop surveillance, environment aggression analyses, controlling the irreversible transformations of the environment, etc.

3. Global positioning System and Mobile Object Management

The Global Positioning System consists of 24 operational satellites disposed on 6 circular orbits at 20.2 km above the earth. The satellites constellation formed of 4 groups of 6 satellites makes a complete rotation above the earth every 12 hours providing positioning information.

The GPS satellites are utilized to calculate the position of a GPS receiver found on or above the earth, utilizing special algorithms which enable positioning in 3 dimensions of the receiver and its motion parameters permanently. The GPS system was completely operational starting July 17th, 1995.

The system developed by the United Stated Department of Defense can now be utilized by anybody. The data provided by GPS have two levels of accuracy, a standard one, SPS (Standard Positioning Service) and a precise one, PPS (Precise Positioning Service). SPS is destined to public use and its performances were decreased in comparison with PPS, in order to protect US security interests. Therefore, in the civil field, the absolute accuracy is 50 meters and can reach the order of centimeters by differential analysis.

Another positioning system, the Russian system GLONASS-COSMOS ensures a civil accuracy of 50-70 meters in horizontal plane, and 70 meters in vertical plane.

Surveillance and monitoring systems of mobile objects (SMO) present hardware and software solutions designed to locate, survey and control mobile objects (ship, vehicles, people) remotely from the central monitoring point.

Any SMO has the following components:

- Equipment installed onto monitored objects;
- Communication system between the monitoring center and the monitored objects;
- Monitoring center.

The monitoring center is equipped with devices designed to determine the geographical position of the monitored object, using the GPS system, memorizing the geographical position achieved, with a system of sensors which determines and memorize various parameters of the monitored object (the speed of the vehicle, roadside hours number, operating parameters of the thrust system, etc.); it is equipped with a processing system of the achieved or received parameters, feedback systems for controlling the monitored parameters, communication ways to various institutions interested in monitored objects surveillance.

Besides the ones mentioned above, there is the communication system with the monitoring center, which can be GSM type, radio, satellite, or combined, with the possibility to switch between different systems.

Essentially, the GPS provides information about any place on earth mentioning its coordinates. The GPS can be utilized as a navigation instrument enabling the safe movement in unmapped or insufficiently cartographed areas. Using this system we can know, at any time, the coordinates where we are anywhere on earth.

The GPS system has the capability to calculate the position of a receiver mounted on the monitored object, or somewhere on the earth surface, using simple geometric measurements and a computing algorithm which assist the receiver in determining which satellite is available for application at a certain time, and to determine the position, speed, and exact time (the reference is an atomic clock), round the clock, anywhere on earth.

The monitoring center, besides the equipment that fulfills the above mentioned tasks, also has a software program which manages all information of the system and which can display on a digital map, the position through time and space of the monitored objects, or other information such as the deviation from a preset route, from the movement speed, emergency alarms, etc.

The main features of a SMO are:

- ✓ Determining the current location of the monitored object and memorizing this position, and representing it on a digital map;
- ✓ Surveying and memorizing the routes of the monitored objects;
- ✓ Monitoring and diagnosing different components or parameters specific to the monitored object;
- ✓ Warning the abnormal situations: deviation from the route, non-observance of the timetable, unauthorized opening of the auto- or railroad- containers;
- ✓ Remotely commanding and controlling different components or devices of the monitored object;
- ✓ Protecting the information within the system.

The potential beneficiaries of SMO systems can be the transportation companies, valuables transportation companies, security companies, emergency systems monitoring companies, companies that monitor the petrol products transportation pipes, customs and border control authorities for surveillance of the movement of vehicles for goods or passengers.

Within the operation of the periodic reporting the position of the monitored object, the SMO system can enable the end-user connected to the Internet to set up the frequency of the messages and to receive, in real time, information about the object, including specialized assistance in case of certain events during transportation.

The feedback feature of the SMO enables for road or naval transportation for instance, optimizing the speed, minimizing the time, delivery on time, etc.

An extraordinary feature of the system is its capability to follow mobile targets in case of asymmetric threats, fight against human trafficking, smuggling goods, armament, dangerous substances and hazardous materials.

The implementation of these systems enables the apparent optimization of the activities, increases their efficiency, and reduces human resources, material and financial expenses.

Transferring the cutting edge technologies to civil utilization constitutes an important way to add value to them, with reduced expenses, in order to achieve applications of high economic efficiency, in most various fields.