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Applying Multimedia Technologies in the Information Systems of the Security and Defense Field

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IT4Sec Reports 114 "Applying Multimedia Technologies in the Information Systems of the Security And Defense Field"In this paper the multimedia systems and technologies are thoroughly considered with a view to their applications in the information systems of security and defense and their their role in the performance of military tasks in the process "Capabilities-Based Planning". Particular attention is paid to the computer visualizations, as one of the main multimedia means of expression that contribute to the more efficient, qualitatively and overall perception of the information.There are presented examples of 3D graphical models, created using a variety of specialized products for design of virtual environments.
The goal is to be made a summary analysis of the most innovative methods and technologies used in the field of security and defense for performing information activities and visualization of multimedia information.

IT4SecReports 114 „Приложение на мултимедийните технологии в информационните системи на сигурността и отбраната" В настоящата разработка са обстойно разгледани мултимедийните системи и технологии с оглед на приложенията им в информационните системи на сигурността и отбраната и ролята им при изпълнение на военни задачи в хода на процеса „Планиране на способности". Специално внимание се обръща на компютърните визуализации, като едно от основните изразни средства на мултимедията, което допринася за по-ефективното, качествено и цялостно възприемане на информацията. Представени са примери за 3D графични модели, създадени с помощта на различни специализирани продукти за дизайн на виртуални среди.
Целта е да се направи обобщен анализ на най-иновативните методи и технологии, които се използват в сферата на сигурността и отбраната за извършване на информационни дейности и визуализиране на мултимедийна информация.

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Chapter One
NATURE AND CHARACTERISTICS OF MULTIMEDIA SYSTEMS AND TECHNOLOGIES

1.1. BASIC CONCEPTS

The concept "***multimedia***" originates from lat. "*multum*", that means „*many*"and "*media*"- *resources, information carrier.* The multimedia means of expression are different in dependence on its purpose, but by nature it represents a combination of software and hardware tools, IT and creative ideas for presentation of information as a homogeneous medium, including text, graphics, sound, video and interactivity, giving to the user the possibility to manage the data stream [1].

The multimedia systems and technologies have a great applicability in the field of security and defense. ***The multimedia systems*** have great opportunities for conducting all well-known information activities related to generation, processing, distribution and visualization of multimedia information by multimedia applications. The development process of multimedia products is connected with construction of a simple and a complex multimedia objects and scenes in compliance with standard MPEG 4. The installation of multimedia products is performed in a specialized storages, that are organized on a corporate or a social principle. The products are systematized and classified in compliance with standard MPED 7 "Multimedia-interface for a description of content" (Multimedia Content Description Interface), by which are created the conditions for production and distribution of multimedia content and the ways to be accessed in a unified digital environment. The delivery of multimedia products is performed after their "packing" in a container, representing a structure that allows grouping of an objects or another containers for the purpose of forming logical packages (for transport or exchange) or logical archives (for organizations). The standard MPEG 21 for delivery of multimedia materials provides copyright protection for the developers.

In regard ***to the multimedia technologies*** there are certain requirements related to dividing of the processing of multimedia data on a standardized and uniform phases, operations and actions; targeted management of the data streams; inclusion of all the range of resources for achievement of the objectives. For the formulation of the objectives it is possible to be output from the definition for multimedia technologies, formulated by the European Comission in 1988 r., which reads that their purpose is creation of a product containing ***"a collection of images, texts and data, accompanied by sound, video, animation and another visual effects (Simulation), including interactive interface and other management mechanisms".***

1.2 CLASSIFICATION OF THE MULTIMEDIA TECHNOLOGIES

For reasons of clarity the multimedia technologies are classified as follows:

- **Basic IT** – information technologies that serve as a basis for development of applied information technologies. This includes: specialized software, computer networks, operating systems, software platforms, GRID technologies. They ensure solving individual parts of challenging tasks.
- **Providing IT** – they provide the realization of the basic and applied IT (element basis, CASE, instrumental software).

[1] Lazarova, Stoyanka. „Izpolzvane na interactivnata multimedia v obuchenieto." Veliko Tarnovo: University Publishing "St. Cyril and St. Methodius", 2010.

- **Applied IT** – they are formed on the basis of the basic IT and are realized through providing IT. They are intended for specialized activities in the process of multimedia production and distribution.

The computer is the main tool for creation of multimedia applications in the contemporary high-tech world. In dependence on the ways of development the data streams over time and their interaction with the user, the multimedia technologies are classified as follows:

- ***linear*** – the information is available continuously and successively over time and the user does not participate in this process;
- ***interactive*** – the user has the opportunity to actively participate in the operation and to influence its development with his solutions;
- ***hypermedia*** – the interactive multimedia turns into hypermedia by creating a structure of interconnected elements, that could be managed by the user.

Must be examined some generic multimedia technologies:

- **DIRECT X** – a set of interfaces for applied programs (API - Application Program Interface) and programming tools, that give an opportunity to the developers to create a multimedia applications managed by Windows, without being aware with the specifics of the hardware. Direct X works as a mediator between the software and the hardware driver as adduces the system commands into specific commands to the given device. The main Direct X modules are:
  - ***Direct Draw*** – provides more direct access to the graphics hardware than WDM (system drivers for virtual devices).
  - ***Direct Sound*** – an interface for hardware for sound and music. It is a mechanism for WAV files playback. It manages everything – from the sound level to the 3D sound effects.
  - ***Direct Show*** – proposes a means for playback of audio and video streams in a different formats - Quick Time, AVI, WAV and MPEG. This is performed through a series of connected filters.
  - ***Direct Model*** a means for rendering and interaction with a large graphics objects that could not fit in real and virtual memory.
  - ***Direct Dimension*** – allows to be combined sounds, images and texts and their connection with an occurrences triggered by the user, dependent on the time.

The multimedia architecture and its elements are represented schematically in the Figure 1:

- ***OpenGL (Open Graphics Library)*** – provides powerful API for 3D computer graphics. It is used for simulations and visualizations of images.It is situated at the application level and is served by Direct X. This standard is widely used because of the following main advantages:
  - visualises 2D and 3D computer graphics, ensuring generation of high quality images in real time;
  - compatibility with a various operating systems – the images look in the same way independent on the operating system;
  - the applications could be realized on a various computer platforms;
  - backward compatibility with the previous versions;
  - flexible architecture, that contributes to continual improvement;

- ***Direct X HAL*** – an abstract hardware. It realizes the interface between the software and the hardware devices. It facilitates the developers, not requiring them to have knowledge for the specific characteristics of the devices.
- ***Direct X HEL*** – emulation level of hardware. Emulation of hardware capabilities that it does not support. 3D is ususally emulated.
- ***Direct X модули*** - – provide the applications to work with a various multimedia devices for sound, video and animations[2]

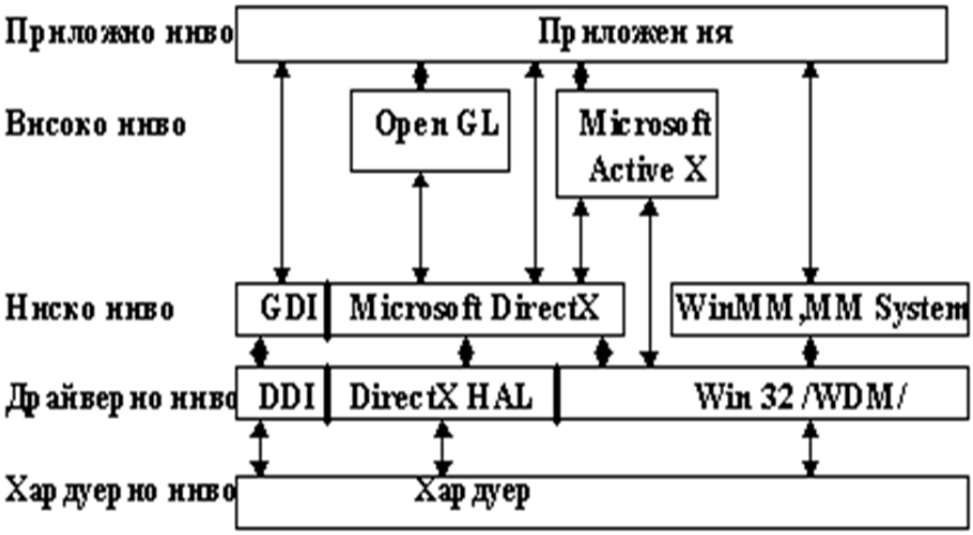

Figure 1

1.3 MULTIMEDIA AND COMPUTER GRAPHICS

The computer visualizations are a main multimedia means of expression and contribute to the more efficient, qualitatively and overall perception of the information. In the most innovative multimedia products the computer graphics and animation attend as a mandatory element for presentation of information. In the scientific fields the computer graphics helps to bring clarity related to a certain project, focusing on the realistic performance of the idea before its final realization. 3D computer modeling is gradually replacing 2D graphics, since it provides greater opportunities for preliminary simulation in a virtual environment. In the military sphere these methods contribute to achieving the accurate planning and help decision making, minimizing the risk of subsequent problems and errors.

The process of 3D modeling and animation is complex and stepwise, which means that some technological time is needed to be created a product, satisfying all the requirements for quality execution and mostly for Realism. In science and engineering is crucial a real situations and processes to be recreated in the virtual reality maximum realistic in contrast to the film industry, where a high level of abstraction is often allowable. As much as a 3D model of a specific object is more accurate, detailed and realistic, so much the expectations for the

[2] Nenova, Stefka. „Multimedia Systems. Lectures.“ www.tuj.asenevtsi.com. 2013.

practical results are higher. The proficiency in specialized software for 3D modeling is a means to be created a realistic model with an option for subsequent animation, import in a virtual environment or a "live" video. There are technologies that make it possible a previously captured human figure or a real object to be cut out from the background and imported in a virtual environment or a "live" video. The filming is made using a professional camera in a special equipped film studio. The background on which the video is captured represents a special green or a blue screen, because these colors do not exist in the human body and a sequent cutting the figure from the background is possible, without disturbing its entirety[3].

The fundamental methods of creating a 3D models in the space are modeling of surfaces (Surface Modelling) and modeling of geometric shapes (Solid Modeling). The 3D objects are defined as a solid forms in Solid Modeling, unlike the first method, using "primitives" that being sculpted similar to a sculpture to give the desired shape. The dimensional surfaces or the standard set of objects in the programs could be turned from a plane figures into a 3D objects, using the Surface modeling by setting a different values for the thickness.

The creation of a virtual reality can find its natural continuation in the process of 3D printing, which makes it possible a material product or its prototype to be made for the purposes of various fields. The 3D printing is a perspective innovative technology that could become a revolution. The principle of work is based on the overlay of layers of different materials (PLA, metal and etc.) to make a 3D object to acquire a tangible form. The sizes of the "printed" object are determined by the sizes of the printer, but there are practically no limits for creation of any items for professional purposes. Particular in the field of security and defense 3D printing can be used for producing of technical equipment, tools, equipment, safety and fire-resistant clothing, a great variety of machine elements. The main advantages of this high technology are that it saves expenses, ensures detail and precision, allowing the creation of a high-quality end product regardless of the level of complexity. It should be noted that although the accessible and relatively easy work with the 3D printers, the qualitative and correct modeling of the object in the virtual space are paramount. It is intended that even a minimal inaccuracies, deviations and errors in the modeling process could lead to distortions and a sudden stoppage of the machine, causing a serious damage. It is necessary all the technical requirements to be complied when working on software, hardware and physical level.

Although the 3D printing is widely used, the full development of its potential is still pending. It could be given a few interesting examples as an evidences for the usefulness of this technology in the military industry. The first 3D gun was created in 2013 and it is called The Liberator. It consists of 15 plastic parts and a metal element that serves as a striker. It shoots only one cartridge, but its efficiency is proved. The first full metal 3D gun (a work of the Texas company Solid Concepts) is a copy of M1911 and is made from stainless steel. It consists of 33 elements and has a butt with a carbon coating, laser engraved for maximum stability of grip. The assembly is with duration 7 minutes. Over 50 cartridges were shooted with the gun and several of the shots are with high accuracy at a distance about 30 meters. The first drone (an unmanned aircraft) assembled of a 3D parts was made by the company Arch Aerial. Proved stable and reliable, it can be used equally effectively for a civilian purposes and to perform a security activities[4].

[3] Ivanova, Yoana, и Stefka Nenova. Computer graphics as a means of improving the quality of military education. Sofia: Publishing House of Military Academy, 2013.

[4] Panayotov, Dimitar. 3D printiraneto i prilojenieto mu v sferata na sigurnostta. 15.01.2014 r. http://www.security.bg/topnews/3d-printiraneto-i-prilozhenieto-mu-v-sferata-na-sigurnostta

Chapter Two
CAPABILITIES AND SPECIFICATIONS OF APPLYING MULTIMEDIA TECHNOLOGIES IN THE INFORMATION SYSTEMS OF THE SECURITY AND DEFENSE FIELD

2.1 SCIENTIFIC DIRECTIONS IN THE FIELD OF SECURITY AND DEFENSE

With reference to maintain the defense capabilities of the country it is necessary to be analyzed the possibilities of conducting a research in this area. The existence of many and diverse information regarding the nature of the research projects and the teams working for their realization it is necessary the main directions for conducting research to be formulated and established.

White Paper on Defense[5] is the first official document, including five such directions:

1. Research related to improving the education quality of the human resources;
2. Research related to the maintenance of CIS and the systems for command and control C4I;
3. Research concerning to the multifunctional systems for providing weapons and ammunition;
4. Research, aiming implementation and use of innovative technologies;
5. Research, contributing to the improvement of the logistic support.

In order to achieve a higher efficiency and a real results it is necessary to be found the balance between theory and practice as the efforts are mainly directed towards the development of more advanced in terms of structure and details Database. With the help of the Center for National Security and Defense Research (CNSDR) at Bulgarian Academy of Science (BAS) is created a more accurate and informative classification of the scientific directions. The structure of the scientific research for defense (eighth version, January, 2001) is shown in ***Table 1.***

Table 1

SCIENTIFIC DIRECTIONSIN DEFENSE	MAIN APPLICATIONS
SYSTEMATIC RESEARCH	Decision Support Systems (DSS)
	Military strategies and doctrines
	System Concepts and Integration
	Phenomenology
	Sensors

[5] „White Paper on Defense and the Armed Forces of the Republic of Bulgaria.“ *www.mod.bg*. http://www.mod.bg/bg/doc/drugi/20101130_WP_BG.pdf

SENSOR AND SENSOR SYSTEMS	Information processing and management in sensory environments
	Components
CIS TECHNOLOGIES	Managing information and knowledge
	Computer and communication technologies, networks and systems
	Technologies for information protection
	GIS technologies
	Architectures and supporting technologies
	Technologies for the integration of communication and information system
	Technologies for testing software and hardware systems.
MODELING AND SIMULATIONS	Architectures for simulations
	Strategy games
	Simulation training of staffs
	Distributed teaching
	Training of parts and divisions (group training)
	individual simulators
	synthetic environments
	Distance learning
TRANSPORT TECHNOLOGIES	Technologies for vehicles and platforms
	Technologies for propulsion and power supply
	Resource, availability, reliability and maintainability
	Environmental impact
	Testing technologies
	Monitoring and operating
WEAPONS AND	Artillery materiel
	mortars
	Means for remote corrugation
	Small Arms and Light Weapons (SALW)
	Engineering ammunition

AMMUNITION	Unguided bombs
	Unguided missiles
	Ammunitions
	Detonating mechanisms
SUBSTANCES AND MATERIALS	Explosives
	Gunpowder
	Fuels
	Lubricants
	Technical liquids and gases
	Technologies for protection from environmental influences
	Technologies for mechanical protection
	Tools, materials and technologies for camouflage
	Non-lethal weapons
	Power sources
NUCLEAR, CHEMICAL, BIOLOGICAL PROTECTION AND ECOLOGY	Means and systems for radiological and chemical intelligence and dosimetric control
	Means of individual and collective defense of the respiratory system and skin
	Methods and means of special and sanitization processing
	Biotechnologies
	Means and systems biological indication and protection
	Environment protection
	High humidity, pressure, vibrations, overload
	Culturological research
	Economy of the defense industrial base
	Social structure and army
	Human factors
	Operative medicine
	Behavior and human protection in hostile environment high and low temperatures, high humidity, pressure, vibrations, overload)

It could be given concrete examples of projects, activities and mechanisms at work for each of these areas. In this written will be examined in detail a various possible applications of the new technologies in the field of security and defense, the relationships between them and the advantages of their using. Last but not least should be evaluated the opportunities for effective use of available resources for research and development to be provided:

- Perspective of research.
- Forming of appear scientifically military policy, plans and programs for the development of military forces, armaments and equipment management system and infrastructure.
- Support the implementation of plans to prepare for membership in NATO, including the targets for partnership.
- The coordination of national efforts in the field of defense research and development.
- Integration of the national scientific community in the system for defense research of NATO and the member states.
- Effectively military scientific and technological cooperation with NATO and our strategic partners.
- Maintenance of human resources and facilities for advanced research and development in the interest of defense[6].

There exist two basic taxonomies of scientific research in security and defense:

- ***taxonomy, developed under a project STACCATO*** - the research related to the civil security are a priority.
- ***taxonomy developed by the European Defence Agency*** – the research related to the national defense are a priority.

STACCATO (STAkeholders platform for supply Chain mapping, Market Conditions Analysis and Technologies Opportunities) is a project, realized under the leadership of the Association of the aerospace and defense industries in Europe. The main purposes of the project are focused on planning of methods and solutions to create a “security market” and "structured supply chain" in Europe by establishing measures for the implementation.

Attention is drawn to small and medium-sized enterprises to integrate their innovation potential and to study ways to coordinate the European Security and Technological Industrial Base. It is needed a methodology for technological observation. It is envisaged analysis of the status and are offered recommendations for the development of a common European market for security equipment (European Security Equipment Market - ESEM), as initially the general needs are determined and are taken into account some regulatory issues and coordination with regional, national, international and European research programs in the field of security [7].

All these activities will be implemented with the support of several segment platform with the participation of all stakeholders, namely consumers, industries, small and medium enterprise and so-called “think tanks”, also known by the name "analytical centers". In its role of NGOs and groups, they focuse their efforts in the human scienses mainly, as their functions are often associated with the development of political strategies, protection of a certain social, industrial or a business policies, conducting a research and an educational programs in order to influence indirectly on the public opinion, having a direct impact on the people who form it. In this particular

[6] Tagarev, Todor. „Organizatcia na nauchnite izsledvania v interes na otbranata.“ Military problerms, 2001.

[7] Martini, Gloria. *STACCATO - STAkeholders platform for supply Chain mapping.* AeroSpace and Defence Industries Association of Europe, 2006.

case the aim is to be implemented new technologies that lead to excellence in various fields. In military the technological development is paramount to achieving the objectives and resolves any problems related to forecasting, planning, organization and management of processes and activities. The needs for innovative solutions increase in all areas of security and defense, but for objective reasons the development and maintenance of communications and information systems (CIS), the renewal of arms and military equipment, medical research and logistic support are a priority. The multimedia systems are a part of the information systems of security and defense.

Table 2 is a matrix that aims to show in which scientific fields of military the multimedia technologies have an application. In the next chapter will be discussed in detail such specific applications.

Table 2

SCIENTIFIC DIRECTIONS IN THE MILITARY FIELD	Multimedia Thechnologies
SYSTEMATIC RESEARCH	✓
SENSOR AND SENSOR SYSTEMS	✓
CIS TECHNOLOGIES	✓
MODELING AND SIMULATIONS	✓
TRANSPORT TECHNOLOGIES	
WEAPONS AND AMMUNITION	
SUBSTANCES AND MATERIALS	✓
NUCLEAR, CHEMICAL, BIOLOGICAL PROTECTION AND ECOLOGY	
SOCIAL, PSYCHOLOGICAL AND MEDICAL RESEARCH	✓

2.2. ROLE OF THE MULTIMEDIA TECHNOLOGIES IN THE PERFORMANCE OF MILITARY TASKS IN THE PROCESS "CAPABILITIES-BASED PLANNING"

For achieving a specific targets is necessary a certain requirements to be met and to be assessed the capabilities of the armed forces and also the risk if they do not meet the set requirements. For achieving transparency, the planning process requires well designed documentation to be traced how certain factors could affect the criteria, the structure of the forces and the resources needed. In preparing the plan should be ensured adaptability, flexibility and robustness as well as its regularly performing. Integrating the methodology in the management system of the development of the armed forces is related to:

- ***K The concept of specialization of the armed forces and decisions related to its application*** – it is required the specialized capabilities to match the characteristics of defense policy and the National Security Strategy;

- ***Time horizon*** – it is intended that the capabilities-based planning is long-term, meaning that the planning horizon, which has averaged between 10 and 15 years, exceeds the time for the construction of the planned capabilities in the future force structure.
- ***Relations with the resource management systems*** – the integrated system for management of defense resources contributes to the realization of detailed planning[8].

In the process of "Capabilities-based planning" are used the following methods:

- ***Method of Scenario Planning*** – it is based on the planning by analyzing of the possible alternatives for achieving a particular result not on the forecasting. For this purpose are made a comparative analysis of the alternatives and assessment of numerous factors, that in one way or another would have a significant impact on the final result. In practice the situational scenarios describe a space within the framework of which a situation could happen in future.
- ***"Delphi" method*** – it is expressed in collecting and synthesizing of expert knowledge by way of group anonymous survey of opinions on the principle of the questionnaire and relevant feedback. The method can be computerized, but in all cases there is a person who controls the overall performance of the process.
- ***„Brainstorming" method*** – generating multiple scenarios that are subject of assessment for problem solving with a high level of uncertainty. The groups consist of 8-12 participants, as the creative process is supported by the responsible person. It is assessed the amount of the offered creative and innovative solutions that are finally evaluated after the defined time for conducting the session.
- ***"Back-casting" method*** – this method represents forecasting. The experts must generate a plausible vision of the future by "brainstorming".
- ***"Workshop" method*** – this is a classical discussion method, aiming to create a scenario during an open discussion[9].

The method of scenario planning capabilities of the armed forces is established efficient for solving of a number of general tasks. The communication technologies has a crucial role in implementing the general military tasks and are applied in the systems for command and control, disclosure, preparation of combat operations providing protection and etc. The situational scenarios shall be subdivided into::

- ***General*** – they are characterized in that being used in determining the basic structure of the forces;
- ***Additional*** – they are used to test the basic structure of the forces and determination of additional requirements to them, and also their structuring;
- ***Concurrency hypotheses*** – it means that two or more scenarios are realized simultaneously or with a very short time difference [10].

Since the focus of this material are the multimedia technologies and the extent of their applicability in the military field, ***Table 3*** is a matrix showing the correlation between the the

[8] Tagarev, Todor. „Metodologia i situatcionni stcenarii za planirane na otbranata i vaorajenite sili." От Metodologia i stcenarii za otbranitelno planirane, от Ministry of Defence. Directorate "Defence Policy". Military Publishing, 2007.

[9] Rachev, Valeri, и Zlatogor Minchev. „Metodika za razrabotvane na stcenarii i kontekstni stcenarii za otbranitelno planirane." От Metodologia i stcenarii za otbranitelno planirane, от Ministry of Defence. Directorate "Defence Policy". Military Publishing, 2007.

[10] Tagarev, Todor. „Metodologia i situatcionni stcenarii za planirane na otbranata i vaorajenite sili." От Metodologia i stcenarii za otbranitelno planirane, от Ministry of Defence. Directorate "Defence Policy". Military Publishing, 2007.

general military task (GMT) according GMTL (General Military Task List), the multimedia technologies and STACCATO taxonomy. This sample includes selected tasks related to the main applications of the multimedia technologies in the processes of command and control, and in particular the maintenance and management of C4I environment. Furthermore the multimedia technologies are widely used in operational planning because of the need to conduct preliminary simulations to minimize the financial and life-threatening risks. They have a key role in the performance of the standard information activities related to collection, processing and dissemination of information, which determines their widespread use in the intelligence and conducting information operations. The methods applied in conducting "media" operations have a high level of technological complexity and efficiency.

Table 3

GMT	STACCATO	Multimedia Technologies
Communicate Information	✓	✓
Ensure information assurance	✓	✓
Assess Operational Situation	✓	✓
Establish Common Operational Picture	✓	✓
Ensure effective use of Cyberspace	✓	✓
Conduct Operational Planning	✓	✓
Execute and Control Operations	✓	✓
Troops Information Support Activities	✓	✓
Collect information on Operational Situation	✓	✓
Collect METOC and environmental information	✓	✓
Integrate, Analyse and Evaluate, Collected Information	✓	✓
Provide near real time Intelligence to support planners and decision makers	✓	✓

For greater clarity will be explained what the basic military tasks represent:

- **Communicate Information -** to receive, relay, obtain, maintain and communicate information from one level of command to another.
- **Ensure information assurance** – to establish measures and procedures to assure the credibility and availability of data and delivery systems.
- **Assess Operational Situation** - to evaluate information received through reports on the general situation and the conduct of the operation, and to provide situational

awareness about the location and status of adversary and friendly forces in the theater of operations.

- **Establish Common Operational Picture** – to gather all information and to process them into a single display (COP) for the benefit of various levels of command, including processing them into a single display (Recognized Picture) for the benefit of various components.
- **Ensure effective use of Cyberspace** – to coordinate with national and international actors in order to ensure the appropriate use of the cyberspace for civilian or military operational activities and to ensure the possibility for defensive efforts in the C4I area in general.
- **Conduct Operational Planning** - to plan the various phases of military operations towards the desired military end-state and to coordinate plannings between command levels.
- **Execute and Control Operations** - to initiate and monitor the application of military force towards the achievement of commander's objectives and exercise authority and direction over assigned and attached forces within a Component Command.
- **Troops Information Support Activities** - to ensure that units engaged in operations have the benefit of a good understanding of the overall situation and their contribution.
- **Collect information on Operational Situation** - to obtain operationally significant information on adversary (and friendly) force strengths and vulnerabilities, threat, operational doctrine and forces (land, sea, and air and space).
- **Collect METOC and environmental information** - to collect and assess operationally significant meteorological and oceanographic (METOC) information on the theater of operations including environmental information.
- **Integrate, Analyse and Evaluate, Collected Information -** to analyse collected information and evaluate the accuracy and reliability of the intelligence and integrate it in the adequate decision making processes.
- **Provide near real time Intelligence to support planners and decision makers -** to contribute to the overall determination of the security situation and notification of critical intelligence at theatre level.

Table 4 is based on STACCATO taxonomy and shows the main technologies, used for implementation of specific military tasks.

Table 4

GMT	STACCATO
Communicate Information	Optical sensor technologies, optical devices, digital signal processing
Ensure information assurance	Information security technologies in carrying out the information activities, CIS security
Assess Operational Situation	Tools for modeling and simulation of the mission; software for data analysis

Establish Common Operational Picture	Virtual reality, tools for design and visualization
Ensure effective use of Cyberspace	Technologies to protect intellectual property from cyber attacks, equipment identification and authentication, encryption
Conduct Operational Planning	Systems for optimization, planning and decision support, expert systems
Execute and Control Operations	Automatization of operating systems, simulation techniques to test equipment, simulators, CIS
Troops Information Support Activities	Means of improving the quality of military education, e-learning, simulators, virtual reality
Collect information on Operational Situation	Intelligence technologies (web, aerial surveillance, tracking, interception of audio and video signals)
Collect METOC and environmental information	Sensor networks, GIS, photogrammetric methods, aerial photography, intelligence technologies, technologies to measure geographical, physical, climatic and etc. parameters of the environment (altitude, temperature, pressure, noise, etc.).
Integrate, Analyse and Evaluate, Collected Information	Intelligent integration (connection of monitoring systems with databases), methods for data analysis
Provide near real time Intelligence to support planners and decision makers	Installation, adjustment and maintenance of the equipment for monitoring and video surveillance in real time as well as the means of communication

2.3 POSSIBLE APPLICATIONS OF MULTIMEDIA TECHNOLOGIES IN SECURITY AND DEFENSE

2.3.1 Geographic Information Systems (GIS)

One of the most important applications is the linking of descriptive information (multimedia, graphic and alphanumeric) with cartographic objects, which is the basis of GIS. The geo-information system is a set of technologies and products that are the basis for the creation of information systems, using spatial data. The alphanumeric information is stored in a database and a table row corresponds on each graphical object. The main features of the objects are their position in space, shape and emplacement. GIS enable this information for the objects to be structured and denoted on maps of the area, that find great application in the military sphere. The digital maps are increasingly replacing paper map because of the following advantage - the possibility all changes that occur in the environment to be automatically denoted on the map. GIS provide

SVG (Scalable Vector Graphics) export because of the wealth of graphics specifications, using vector formats as well as raster formats. GML (XML – based language) is exclusively used

by them to describe the rivers and trails and can be converted to SVG. By the means of 3D computer graphics are achieved more realistic and informative images compared with the two-dimensional images. There are various methods of obtaining geospatial information for the purpose of military intelligence, cartography, topography, archeology, etc. An example of this is the aerial photography for taking pictures of the earth's surface from the board of airplanes, helicopters and other aircraft. ***Photogrammetry*** (from Greek: "*fotos"* – light, "*grama"* - drawing; "*metreo"* - measurement) is a scientific discipline that deals with the extraction of information about an object of its photography (shape, size, position, various quantitative and qualitative characteristics).

ENVI (Environment for Visualising Images)[11] is used for the purposes of photogrammetry for quickly, easily and accurately information extraction from images. In geodesy and cartography photogrammetry is called phototopography or photogeodesy since it is used for creating and updating topographic maps and plans with different designation. Photogrammetry is two types depending on the place of photographing:

- ***terrestrial photogrammetry*** – to capture the mountainous places;
- ***aerial photogrammetry*** – the capture is from an airplane and is used to create plans and maps of all areas.

According the amount of photographs photogrammetry is:

- ***uniform*** - aerial photographs are used mainly for the development of situational plans;
- ***dimorphic*** – it is applied exclusively as stereo photogrammetry using stereoscopic effect obtained by the overlapping of the pair of aerial photographs. In stereoscopy the 3D illusion of depth is achieved by reproduction of binocular vision by submission of 2D graphics that are different quite a bit similar to the human eyes. In fact, the human brain compares the images from the left and right eye which see from a different angle.

The type of information that is obtained from the aerial photographs determines the following types of photogrammetry:

- ***metric photogrammetry*** – it is used to determine the location and the parametric characteristics of the objects. In turn, it is divided to:
  - ***analytical*** – for constructing mathematical models of the objects based on data obtained from photographs by measurements, using simple but precisely calibrated devices. The calculations are made with computers.
  - ***analog*** – on the basis of the photographs are built optical models of objects that are subjected to measurement analysis using equipment.
  - ***digital*** – this type of photogrammetry is the most innovative, because it enables creating of 3D aerial photographs, that could be subjected to further analysis and processing using a specialized software

- ***interpretative*** – it helps the objects to be recognized and their specifications, content and relationships to be clarified.

The creation of aerial equipment for the purposes of the military intelligence began in 1911, when the first aerial camera was invented by the Russian military engineer colonel Potte. There

[11] „High-tech software solutions from ESRI Bulgaria." www.esribulgaria.com http://esribulgaria.com/wp-content/uploads/2013/07/2.7.1.Brochure_ENVI1.pdf

are two different types of photos depending on the position of the aircraft during the filming process:

- ***vertical*** - the shooting axis is vertical to the terrain. The vertical photos are used as an orthophoto maps after geometric corrections of the terrain;
- ***inclined at a certain angle***.

The photos are a few types, depending on the purpose and the way of shooting:

- ***single*** – for shooting of single objects. Their decipherment provides preliminary information for the ground surface;
- ***tape*** – the shooting mode is automatic with an overlap from 30 to 65 % between the photos;
- ***surface*** – they have several overlapping strips from 20 to 30%.

The height from which the photos are taken is between 1000 and 2000 meters.The aerial cameras for capturing the ground surface are increasingly sophisticated, making it possible ***stereoscopic photos*** to be captured. The cameras are fixed by a spring buffers in order to reduce the vibrations of the aircraft. The so-called aircrafts “Slow walk” are used.

AN-30 is a specialized a Russian aircraft for aerial intelligence and aerial photographs. The aircraft is pressurized and equipped with a special navigation equipment for aerial photographing. L-410 is a Czech photogrammetric option. It can take off and land on a small soil runways and maintain low speeds of flying[12].

The aerial cameras differ depending on the principle of work and their purpose. According to the purpose for which will be used the cameras are divided into two major groups:

- ***metric –*** measurements are made on the basis of the photographs and the location, size and geometric shape of the object are determined;
- ***non-metric*** – photographs are photo-interpreted by photo deciphering.

In photogrammetry ***holography*** is used for obtaining of ***direct holograms for photogrammetric presentation,*** based on the principle of Frennel. It is typically for them that the obtained image is a copy of the original and it can extract data with high accuracy. In this sense the holographic images can be used instead of the pair of stereoscopic images. ***Focusing holographic stereo models*** are used for the purpose of cartography. Their main advantages are the absence of apparent displacement of the position of the observed object as a result of the observation of two different points (parallax) and a disorder the similarity between the object and its image as a result of distortion (distortion). The holograms are 3D images that are obtained on the photographs due to the superposition of two light beams (interference) and the integrity of the wave surfaces (diffraction). Lase light is used[13].

It is not necessary a film to be developed or images to be scanned if a digital camera is used. The coordinates of the projection centers of the photos and their tilts are defined by analytical aero-triangulation, after that the orthophoto is created and the data are extracted from

[12] „Upatvane za aerofotosnimane.“ www.theplan.net. 1993. http://www.theplan.net23.net/14N16.pdf

[13] Koeva, Mila. „Holography - principles and applications in photogrammetry.“ www.milakoeva.weebly.com. 8 11 2002 r. http://milakoeva.weebly.com/uploads/7/3/2/0/7320208/holography-mila.pdf

the image. The ***orthophotos*** are orthogonalized images, meaning that it should be passed from central to orthogonal (perpendicular) projection. Every photo is in central projection and every map in orthogonal projection. This process needs the spatial positions of each picture and digital terrain model to be defined. All orthogonal images are combined in the so-called mosaic by color and geometry. The obtained orthophoto map can be used as a whole image of large dimensions, as well as be divided into separate parts by predefined division and nomenclature. The orthophoto map is usually TIF, JPG or MrSID for encoding raster graphics. In Google Maps are widely used large groups of images taken from different sources, which are divided into "tiles" (tiles) with size 256x256 pixels. Google Earth overlays orthophotos or satellite images on a digital elevation model to simulate 3D landscapes. Google Earth is constantly updated and it was originally known as Earth Viewer 3D. By its nature it is a software program for geographic information including satellite, aerial photographs and 3D GIS and is projected onto a virtual globe. The use of the World Geodetic System 1984 (WGS84) is typical for it. 3D Google maps can be embedded in web pages by Google Earth API using JavaScript.

Among the latest technologies to capture various objects in the air is ***3D laser scanning (Light Detection and Ranging-LIDAR)*** for accurate dimensional coverage and presentation of a terrain by creating a digital model. Lasers with a wavelength of 600-1000 nm are the most frequently used. The advantages of laser scanning are: high density of the measurements in a short time and the possibility to capture with high accuracy even in low visibility. The vertical resolution need to be not less than 0.01 m. The vertical accuracy within the error tolerances must be 0.15 m and the horizontal accuracy - 0.25 m. The laser scanner sends thousands of laser beams per second to an object from which they reflect back to the scanner. It is necessary this time to be registrated in order to determine the distance from the scanner to the point of reflection of the beam. The position of the beam relative to the scanner and the position of the scanner relative to a given geodetic coordinate system are also registered. In the air scanning is commonly used a helicopter with GPS and inertial system that determine its position relative to the geodetic coordinate system. The laser scanner can register 3-dimensional for 4 to 6 points per square meter by aircraft overflying the terrain, as the set of points is called “clouds of points” that are processed by software. In that way the ground surface can be covered and presented numerically with great accuracy and relatively fast. Another application of the laser scanning in security and defense is capturing 3D photos with a high realism of disaster areas or scenes, allowing effective plans to deal with emergencies to be developed on the base of virtual models. The mobile laser scanning systems are suitable for field work, because they can be effectively installed on a moving platform as well as on flying machines. The mobile cartography is one of the main purposes of these systems. Such a systems are: VMX-250 Riegel, Austria; Mobile Mapper LYNX Optech, Canada; Cartographie mobile L’INSA, Strasbourg. VMX-250 includes 6 separately managed digital cameras and except this it integrates an inertial and GNSS systems. Alongside the ground and aerial laser scanning, there is a space scanning that belongs to the methods of remote sensing. Specialized software is used for processing and analysis of data from laser scanning, as Cyclone by Leica Geosystemsthe is the most commonly used mainly because it processes roughly scanned 3D clouds of points and has great possibilities for data organization, visualization, geodetic surveys and connecting the separate clouds of points. Other packages of programs that are widely used into practice are: 3D IPSOS (Mensi with modules: Core Module, Consolidation, Reconstruction, other modules such as engineering module, module used for pipes, figurative module used for converting of 2D to 3D); LIGHT FORM MODELLER (LFM) на Zoller + Fröhlich; LFM Register,

GENERATOR, SERVER, VIEWER, MODELLER, Operating & Processing Software RiSCAN PRO на Riegl[14].

Besides not only photos but also video can be captured in the air. ***The Spatial Multimedia technology*** is increasingly developing, including digital media, 3D modeling, photography, panoramic photos, video and audio, data for location and time that are obtained by GPS (Global Positioning System). 3D modeling allows realistic visualization of the terrain and the objects in it, enabling the relations between the objects in the 3D space to be analysed. Each 3D element can be connected to a database. The overall design of "digital cities" is based on this principle. Points are situated on the 3D model, serving as a guide to additional multimedia content - photos, videos, text documents, links to web sites and etc.

There is a great variety of advanced software products that offer great possibilities for visualization and editing of 2D and 3D images, containing geospatial information for analyzing the incoming data as well as their storage and management. Software like ArcGIS[15], Bentley Map V8i[16], RDAC, SPACEYES would be of interest to the experts in the area.

Another innovative software product for close range digital photogrammetry is PHOTOMOD, used by GIS SOFIA Ltd. The processes are manual or semi-automatic and the interface is comfortable for usage. It has its own system for vectorization of images. PHOTOMOD includes 11 modules, as especially PHOTOMOD StereoDraw (3D stereoplotting) are two[17].

GeoShow 3D is a programming suite for viewing, creating and editing of realistic 3D models of the terrain and the included in it objects, as well as documenting photos. The advantages of the product are: intuitive control; 3D visualization of terrain, buildings, roads and geographic objects; ability to add photos and files; tools for measuring distance, area, profile and height[18].

2.3.2 Simulators

The preliminary simulation has an important role in preparation for real combat operations at the stage of the planning and forecasting. This is because it allows any problems and errors that can occur in real situations to be predicted and registered. The risk can be minimized this way. If it is not possible the risk to be totally avoided, then the results of the testing research help for taking an early actions related to inevitable consequences of unforeseen risk factors. This is a part of the organization and management processes.

In the simulators may be simulated a mobile platforms, battles, shooting at moving targets, cockpits and etc. Initially, when they entered in use, their simple principle was expressed in projecting images on a screen. Thanks to the emergence and development of 3D computer animation for creating a virtual reality, the advanced simulators are perfect and accurate systems for evocation of the dynamic and ever-changing environmental conditions. The intention is the

[14] Milev, Georgi. „Lazerno i radarno skanirane." www.geodesy-union.org. 2012. http://geodesy-union.org/images/GKZDATA/lazer-radar-scan-milev-01.pdf

[15] *GIS, Photogrammetry and Cartography. н.д.* http://www.metrisys.com/category/products/gis-mapping-systems/

[16] *GIS, Photogrammetry and Cartography. н.д.* http://www.metrisys.com/category/products/gis-mapping-systems/

[17] Petrova, Vanya, и Mila Koeva. „Digitalna fotogrametria v GIS." http://milakoeva.weebly.com/. http://milakoeva.weebly.com/uploads/7/3/2/0/7320208/gis_sofia.pdf

[18] *GeoShow3D Lite.* н.д. http://geoshow3d-lite.software.informer.com/

achievement of maximum realism. In this way, the trainees work on their abilities for rapid response in various situations, such may not always be recreated naturally in ordinary training teachings. It means that the financial investments in genuine teachings exceed those for their simulation in 3D environment. Furthermore, they are at unreasonable risk that must be avoided. Because the resources are valuable, no matter if they are human, material or financial and must be used rationally and by purpose for achieving the ultimate goal.

The simulators can be classified as follows:

- ***Laser simulators of weapons effects*** – also known as tactical simulators and used for simulation of weapons and shooting at a moving or stationary target. The laser is an optical device that generates an intense monochromatic beam of coherent light. This is related to the interference, i.e. with amplification or attenuation of the waves in their superposition. The simulation is characterized by a high degree of realism, because a hit triggers a system that reports the result. The launch of such developments began more than 20 years ago, as was started by the U.S. Army with the construction of the National Training Center at Fort Irwin (California). The comprehensive system for tactical simulations ***MILES Tactical Engagement Simulation (TES)*** is created this way. The U.S. example is followed subsequently by the British army and the armed forces of Germany, Sweden and France[19].

The TES systems use "laser weapons" and special detectors of the beams that are attached to the cars, armored vehicles or the soldiers are set to be triggered with “hit”. Specially designed laser detection systems may recreate the effect of a certain type of weapon to achieve the greatest possible realism. The main advantage of the TES system is the digitization that allows the “battle” to be recorded and stored in the database for analysis of the results.

Aviation operations can be reproduced in a similar way using such systems that contribute to the detail and realism of the training model. The U.S. Army uses similar complex systems also for training of the Navy submarine, but the experts still evaluate them as a substantial investment, which prevents their widespread use in other armies.

- ***Platform simulators*** – for training. They were used during the World Wars to get acquainted with the equipment and working out in advance of emergency situations. As technologies evolve it is already possible takeoff landing maneuvers to be realized. But the most innovative allow simulations of battles, effects of defeats and actions in formation, as well as a number of military scenarios to be played. The 3D computer graphics and animation have contributed enormously the ordinary flight simulator to be improved to " mission simulator" for training not only piloting skills, but also teamwork skills by passing through all the stages of the mission - from a pilot briefing of the taking off to set up strategies, perform specific tasks in a virtual environment and returning to the base. During the whole process, the data are stored and used not only for training, but also for use as a part of the real operations.

- ***Simulators of command laboratories*** – widely used in NATO (North Atlantic Treaty Organization). They include simulations of command and communication procedures. In some of the effective simulated command posts there are opportunities to "import" of electronic and radio interference that are typical for the real combat operations. The contemporary simulation solutions of this type are applicable to all the armed forces and

[19] Arsenov, Anton. „Virtualnoto boino pole s kliuchova rolia v razlichni aspekti na voennoto obuchenie.“ 2007. http://cio.bg/1534_virtualnoto_bojno_pole__s_klyuchova_rolya_v_razlichni_aspekti_na_voennoto_obuchenie.

can be used for training by interaction between different commands when is required large scale joint actions to be conducted.

- ***Combined simulators*** – for playing the whole battle. They include also simulation of weapons, shooting, moving platforms, command laboratories and etc. With a compact modern computers and network components, a "workstation" can simulate actions of entire platoons and battalions teaching the crews to "counteract" in a realistic virtual geographical environment created by using advanced GPS and GIS technologies. This concept is called Distributed Interactive Simulation (DES)[20].

3D computer graphics and sound effects predominate in simulators on mobile platforms and the simulator of shooting. There are a specific requirements related to the quality of the graphic images and the technical parameters of the system that need to be met:

- ***High resolution –*** not less than 300 dpi;
- ***Powerful computer*** – for visualization of the scene and performing the mathematical calculations required;
- ***Interface for connection with the command laboratory;***
- ***Real – time visualization of 3D images and scenes –*** it is used the special technology Direct 3D, that is designed to accelerate and does not require large memory and does not depend on the devices. This makes it a very appropriate solution;
- ***smooth animation and application performance in full screen*** - graphics can be displayed via Direct Draw (част от Microsoft DirectX Application Programming Interface). Direct Draw provides an opportunity applications to be performed in full screen, animation to realize smooth and contains commands for 2D visualizations, but does not support 3D hardware acceleration. Usually, when talking for hardware acceleration it means the video card, because there are already video cards that relieve the CPU. They have a chip that performs specific calculations. In some sense the term "3D hardware acceleration" is not actual, because Direct 3D is already exists.

The conclusion is that the military simulations provide opportunities to overcome problems arising from changes in military doctrines that affect the combat capability of the army and the conditions of training. It means that in this way the focus is on the peacekeeping, humanitarian and rescue operations, as well as on counteraction to natural disasters and terrorist attacks that require fewer resources (military equipment). It is important to be paid attention that compromising the quality is not permissible and the simulations have a proven advantages. There are some directions in the military sphere, where the 3D visualizations have not entered at this stage, but would be needed and the technologies will be sufficiently developed to overcome these deficiencies in future. The proof is the evolution of simulators that have been a projection on a screen at the beginning of their creation, but now a complex computer systems contribute to visualization of animation and computer graphics high class. The efforts are focused on the security arrangements since computer simulation models of real battlefield are often the target of attacks. This is so-called “simulation war” (cyber war). At first sight the system continues to work perfectly correctly, but the aim is the final decisions to be misleading and even wrong. The main thing that should be done to prevent such problems is proper selection of skilled staff.

Some concrete examples of professional military simulators can be given in support of the above:

[20] Arsenov, Anton. „Virtualnoto boino pole s kliuchova rolia v razlichni aspekti na voennoto obuchenie.“ 2007.

- ***DITS (Deployable Instrumented Training System)*** – a modular and mobile system with modern laser simulators, offering innovative opportunities for training with the already installed equipment suitable for field training. The contract for the supply of DITS for the Bulgarian Army has won by a program of the U.S. Foreign Military Financing FMF (Foreign Military Fund). The contract is from the program for overseas military supplies FMS (Foreign Military Sales) of the subdivision for simulations and training of the U.S. Army. This system provides control in training, monitoring of combat mission, data collection and rapid analysis of actions (After-Action Reviews (AARs) in the conduct of the training in real time. The Bulgarian system is the same like the systems in the US Army and the US Navy. DITS is used in Europe by the U.S. Army since 2001. It is used already in Bulgaria in a joint trainings in 2004, 2006 and 2008.

- ***ARMA III*** – one of the newest tactical military simulator as a situational game that was made by the Czech studio Bohemia Interactive Studio. The previous version of ARMA II is created for Microsoft Windows OS. There are several thematic versions of the simulator. The topic of ARMA III is related to a mission in Mediterranean region. Captain Scott Miller manages a team of NATO, which ends up in the inhospitable and dangerous island where a hard struggle for survival is going to happen. The situational game offers opportunities for vehicle control. The computer graphics is provided by ***"engine" Real Virtuality 4*** compatible with ***DirectX 9,10 and 11***.

Some clarifications are needed regarding the usage of the concept engine, because in this case it is not used its literal meaning. This is a unified name of the full suit of programming tools for visualization of 3D virtual reality. The graphic engine is a programming part of the code of the game that makes the calculations for the visual imaging of the scenes. It has several tasks:

- calculations determing which objects are covered by the eyesight fastest;
- rendering the scene;
- realistic and smooth visualization of the animation.

The rest part of the graphic is up to API (Application Programming Interface). This is the interface of the source code that the OS or its libraries of low level offer for the support of the requests incoming from the application software or computer programs. The code contains all the information, indicating how some operation will be done by the program. The graphical interfaces contain all the information regarding texturing, visualization of video effects, references to the buffers or the memory of the video card and etc. There is a difference between API modules and the software that uses them (implementation на API). In this sense the graphical engine is an implementation of API, because it uses a set of libraries provided by DirectX/OpenGL. It is necessary to note that the newest version 11 of DirectX is improved compared with the previous ones. Windows 7 includes a new version of this software for 3D computer graphics, impressive visual and sound effects. The software is characterized by high efficiency, power of the modern multi-core processors, support of complex texturing techniques. The 3D animation is smooth and extremely realistic[21].

- ***JADE (Joint Air Defence Training Simulation)*** – an experimental simulation which has been conducted in Norway (March, 2006). The objective is the compatibility between the simulators and operating systems to be explored in conjunction with a group tactical training. The experiment includes virtual simulators, constructive simulations and embedded simulations for management and control TDLs (Tactical Data Links), a

[21] *DirectX 11*. н.д. http://windows.microsoft.com/bg-bg/windows7/products/features/directx-11

simulation game for commercial purposes and toos for the visualization and its management[22].

The training includes: CRC (Control and Reporting Centre), three frigates and a fighter, procedures and means of technical control (aerial photography, air-marine procedures, navigation). There are many simulators with similar or the same purpose and functionality, but JADE is the first of its kind joint training exercise based on distributed simulation using 2D and 3D computer visualization.

- ***LVC Simulation for Training of Ground Commanders*** – simulation to train commanders created by connecting the different simulators to "live" BMS system.

The device is presented at the annual forum for representatives of the armed forces, industry and academic circles (Cologne, Germany, May 2011). The integrated solution consists of:

- IFACTS – an air simulator provided by IFAD TS;
- IRAS*COM – a radiocommunication simulator, which is also provided by IFAD TS;
- Steel Beast Professional – a simulator of an armored vehicle (by eSim Games);
- SiteWare BMS – system for management of the battle (by Systematic).

One of the main requirements for the purposes of LVS is achieving compliance between the real world, the virtual reality and the technologies for realization. All the systems are computer-based, which helps to some extent for reducing the high complexity.

Simulators require 3D simulation environment in which the user to move, because the training process needs communication between the trainees. The navigation in the virtual reality as an analog of the reality and its explore is a part of the training. It is absolutely essential digital maps to be used for a specific purposes, as each system uses a different format maps and 3D terrain. Therefore LVC needs a tool for export in a format that is suitable for use by every system. Aerial and ship simulators are widely used in the military sphere. Aviation simulators are also called piloting and make it possible a real militant atmosphere to be represented, when they are used for military purposes instead of civilian purposes. Simulators are the only way that enables various random and infrequent events that are possible during a flight to be simulated on a place many times. In this way the pilot prepares for action in such situations, improving his reactions and habits to deal with them. The simulators for a civil not maneuverable aircrafts are more improved compared with the simulators for a military aircrafts. The explanation is that the standards JAR-FSTD and ICAO 9625 accurately define the correspondence between the model and the real plane. The simulators that are certified to the highest level in Level D by JAR-FSTD or Level VII by JAR-FSTD ensure advanced level of realism and an additional training for pilots is not required. They also allow these pilots to be joined to the flight crews immediately after the completion of the conversion course for a new type of aircrafts by using a simulator installation.

The contemporary aircraft simulators are divided into two large groups:

- ***Procedural simulators FPTD (Flight Procedures Training Device)***

It is typically for them to be used for preliminary working off and execution of the flight. The control panel, instrumentation and some certain controls are usually imitated with touch screens. In

[22] Mevassvik, Ole Martin, Bråthen Karsten, и Richard Moe Gustavsen. „JADE – An Experiment in Distributed Simulation Based Joint Tactical Training.“ *http://www.cso.nato.int/*. н.д. http://ftp.rta.nato.int/public/PubFullText/RTO/MP/RTO-MP-MSG-045/MP-MSG-045-18.pdf

some more expensive simulators the cockpit and the control panel are presented with a models in real size. This is being done in order to more qualitative training to learners. Certainly, this situation during the training is universal and should be noted that there are a great variety of brands and models airplanes. Most commonly the procedural simulators are not designed to simulate the flight and are not equipped with a system for visualization. This explains their comparatively lower price. Particularly in Bulgaria there are procedural simulators of the type Flight and Navigation Procedures Trainer (FNPT) in the centers of the Institute of Air Transport and Bulgarian Aeronautical Centre[23].

- ***Complex simulators FFS (Full Flight Simulator)***

They are more interesting because of two main reasons. They are equipped with motion systems that enable the simulation of the spatial arrangement of the aircraft. The cabin of the simulator is an absolutely precise model of a real cockpit. The visual display systems are another important advantage of this type of simulators. They are projective and collimated. Common between them is that the image is projected using a projector on cylindrical or spherical screens. The projective systems for visualization are characterized in that design of the image is on the screens near to the cabine of the simulator. As a result there is a correlation between between the line of remote monitoring of the objects and the position of the pilot's eyes. Therefore it is necessary the angle of that error φ to be determined by the following formula:

$$\varphi \approx 2 \operatorname{arctg} (L/2R).$$

L is the amplitude of the lateral movement of the head of the pilot, and R is the distance from his head to the screen. It means that the projective systems have a significant disadvantage, because if the distance between the pilots in the cockpit L=2 m the angle of the error will be equal to 37°. There is only one point where that error has the value 0 in the simulators of this type and this point coincides with the place of the pilot. It is an important feature that an aircraft with a crew of two pilots can be controlled from the left and right pilot. In this case two points of zero error are provided in the visual display system as a possibility of switch from one to the other pilot's seat is available. The collimated system is more improved compared with the projective system. In the collimated system the light rays from all points of the observed distant object are parallel each other in reality unlike the projective system in which the light rays for each point of the object disperse evenly on the screen in all directions. The collimated system for visualization is extremely expensive because can simulate the landing of the aircraft. The collimated systems are installed on the complex simulators FFS and FTD FTD Level 2 (Level 2 by JAR-FSTD). The American company Rockwell Collins is a leader among the producers of collimator visualization systems, becausde it provides the spherical mirror band for projecting the image that is the main element of the system.

With the development of the new technologies 3D visualizations provide more opportunities for realistic recreation of the objects, increasing the education quality. Universal simulators with use a 3D-visor for the user already exist. Such is the UMS (Universal Motion Simulator), that can combine practically everything (management plane, helicopter, tank, truck, motorcycle or even a spaceship). The simulator is developed at the University of Deacon (Australia) and has unlimited opportunities for simulation, as it is especially suitable for aviation simulations. According mto its creators UMS is "A giant industrial manipulator with a hand (8 meters) at the end of which is mounted a chair"[24]. This is a unique simulator that can reproduce an enormous overloading in flight

[23] *Flight simulator.* 2011. http://en.wikipedia.org/wiki/Flight_simulator

[24] *Universalen simulator ot Avstralia. 2011. http://fakti.bg/technozone/23157-universalen-simulator-ot-avstralia*

at a height only 7 m above the ground, unlike the conventional simulators in which only the chair tilts in different directions. Its six degrees of freedom are a great advantage, because they allow performing rotational movements in all directions with the required speed. Except the possibilities for 3D visualization UMS creates physical sensations of touch that are generated by vibrations in the steering wheel or joystick and the efforts being made to management. These features do not exhaust the brilliant technological specifications of the simulator. Due to the fact that it is designed for reproduction of heavy dangerous emergency situations and aerobatics, the developers have thought about how to monitor the physical condition of the trainee by electrocardiogram (ECG) and electroencephalograms (EEG). EEG is a test for measuring the electrical activity of the brain by a specific electrodes, connected to a computer. A sensors are placed on the head of the pilot. The computer records the electrical activity of the brain, and the required information is obtained on paper or displayed on a monitor. The electrocardiogram is practiced even more frequently, as with it the output shows the electrical activity of the heart. The electrical voltage produced by the electrical conductivity of the heart is measured by an electords that are placed in different parts of the body. It is important to emphasize that UMS is suitable for use in military, because it can realize virtual air wars of great distance regardless where in the world are the participating pilots.

From the view point of the situation in Bulgaria a good example can be given with the ship simulator for control maneuvers and modeling of rescue operations, which was officially presented in March 2011. It is designed for training of captains and security officers.

The simulation scenario is related to an accident between two ships in the port of Rotterdam and rescue operations. The simulations allow a walk along the navigation bridge virtual access to any part of the vessel and recreating the situations at the harbor in Varna.

From a technical view point the simulator provides an opportunity for the calculation of the speed and direction of drifting objects, as well as to determine the area of search and rescue. The region, where the rescue means detects the damaged object is displayed by specialized software. The workplaces include a digital map GMDSS (Global Maritime Distress and Safety System), FM, Radar (**RA**dio **D**etection **A**nd **R**anging). The simulator is equipped with cameras for video surveillance and documenting the exercises as required by Executive Agency "Maritime Administration" (STCW-78).

The training complex is of interest, because it consists of 3 modules:

- ***Modul 1*** – a navigation bridge with a control panel and a screen for visualization of the situation at the harbor or in the sea. The module complies with Class B by DNV and has the following technical capabilities: 120° overview for monitoring; management of the ship using a special motion devices (“azimuth” from English); simulating emergency situations with an alarm panel; simulating GMDSS communication equipment; simulating fire fighting on the ship.
- ***Modul 2*** – a room for training in control maneuvers of the ship with three workplaces connected into a network and a communication system and equipped with control panels Class C by DNV (consoles, without propellers).
- ***Modul 3*** – instructional control panel for management and control of the exercises and trainings which are conducted using the simulator[25].

[25] „Koraben simulatcionen trenajor.“ www.new.tu-varna.bg/. 2011. http://www.tu-varna.bg/tu-varna/images/stories/Novini/Valia/3/PREZENTACIA_TRENAJOR.pps

Usually the simulators of new generation use innovative accessories like virtual reality 3D stereoscopic displays, which are placed on the head, gloves, 3D controllers, special chairs, VR simulators and more. For example, Virtual Viewer 3D is lightweight and convenient to be placed on the head and suitable for 3D PC and 3D video applications. It provides full-color image with high quality. It can be connected to any computer using graphics SVGA (Super Video Graphics Array) 800x600 or DVI (Digital Visual Interface) connection. DVI is a digital video cable, which is used in desktop computers and LCD monitors. They are closest to the the VGA connectors with 24 pins and support for analog and digital video. DVI does not support audio and broadcast up to 1920x1200 HD video which means that they can support up to 2560x1600 pixels. Some DVI cables or ports have fewer pins if a very high resolution is not required. DVI does not support HDCP encryption by default. Therefore, it is not possible HD Blu-rays or other HD content to be watched if there is DVI only. Virtual 3D Viewer is fully compatible with Windows XP, Vista / 7, and every video card, turning each simulation game or application in stereoscopic 3D. It can also work with a standard DVD player. 2D DVD can be easily converted in 3D using 3D Converter. Virtual 3D Viewer seamlessly connects to a video camera or game consoles - Xbox, Gamecube, PS2, PS3, Xbox 360 and etc. The integrated headphones reach Stereo Surround Sound and the so-called "Eye-cups" block penetration of light outside. These advantages make Virtual 3D Viewer widely used by doctors, dentists, medical doctors, NASA, U.S. Navy, law enforcement agencies in the U.S. and abroad, and for scientific research.

The special gloves (data gloves) are different types depending on their purpose. Peregrine Gaming Glove is an innovative product and represents an input device that is an analogue of the human hand for “increasing” the keyboard. This glove is characterized by high compatibility with all types of computer games. It is constructed of durable, flexible sensors, and has 18 points of touch as a touch of the finger is enough to command the game. There are more than 30 instantly available actions. Peregrine works with any application that can accept keyboard input - for Windows, Mac OS or Linux. The control schemes for each game or application can be set as using standard drivers for the keyboard.

"Chair" is another accessory that is commonly used in the simulation of virtual reality. VR Motion Chair is a good option for both professional and personal use. The simulations of flight and driving are characterized by great realism. Usually it is combined with a 3D display which is placed on the head. Control is possible by a joystick or a steering wheel. A special device like Interactor Vest is placed on the back for physical sensations during the simulation. Interactor Vest is available in different sizes and can be connected to any audio and video sources, including PC and game console[26].

2.3.3 Artificial Intelligence Systems

Artificial intelligence (AI) find application in more and more fields - medicine, robotics, business and etc. They are increasingly used in the military sphere. They are characterized by the creation of a knowledge base, including extensive information – text, graphic and video information. The main function of the AI systems is pattern recognition that is used in various fields. For example, in military sphere these objects can be vehicles, war machines, aircrafts and etc. In the knowledge base of expert systems for pattern recognition can be implemented 2D, 3D images and computer animation in multiple variations, helping for visualization of different processes and

[26] *Virtual Realities Products.* н.д. http://www.vrealities.com/product

phenomena. In a general sense pattern recognition unifies methods and tools for perception of objects in the surrounding world.

- ***reading of handwritten and typed text;***
- ***pattern recognition from a distance;***
- ***determination of the spatial coordinates, orientation, quantitative and qualitative characteristics of the 3D objects from a distance;***
- ***recognition of tactile images*** – they are perceived by touch of the hand. It is widely used in medicine for diagnostics of some diseases of an organ by "touching".

Much of the expert systems use knowledge that are represented as a production rules (Rule-Based Expert Systems), combining theoretic interpretation of the issues and a heuristic rules for their decision. They are created using an obtained knowledge by experts and their encoding into a form that the computer can apply to analogic problems. In this sense an expert system is an intelligent computer program that uses knowledge and inference procedures to solve complex problems. The conclusions are drawn on the base of human knowledge that are presented using a production rules. Their interpretation is carried out on the principle of the “straight” conclusion (managed by the data) and the feedback (managed by the objectives).

This direction of AI is used in practice for the work of the specialized agencies in the prevention of terrorist attacks, drug trafficking and reduce crime. Examples of this are the systems for: face recognition by video data of public places that are potentially at risk of attacks; fingerprints recognition in border control; search for clues of crimes. These methods for pattern recognition are successfully used by security and satellite systems for military and civil use even in conditions of poor visibility.

The systems using images need a graphical environment for visualization. The system of graphical representation can be two-dimensional or three-dimensional. SVG (Scalable Vecto Graphics) is a XML-based graphical format for describing 2D graphics. Its important advantage is that the quality of image is preserved at resizing.

The file format ***VMRL (Virtual Reality Modeling Language)*** is used for:

- description of 3D objects, animation and virtual worlds;
- exchange of multimedia;
- visualization and remote control of robots combined with JAVA VRML.

The following tasks must be completed in the construction of an intelligent system that uses knowledge bases:

- ***First stage***

The main thing in designing the system is defining of the problem or the task that must be completed. This stage includes the complete concept for the method that will be used.

- ***Second stage***

This stage is the most complex and is associated with the provision of the necessary knowledge and their systematization and coordination. It includes the following steps:

- the designing of the method for drawing a conclusion;
- software selection;

- detailed research and an analysis of information related to the specific area;
- collecting and presenting all types of knowledge for: the object, situations, performances, meta knowledge (knowledge about knowledge), state space, logical circuits, semantic networks (describe the reality by objects and binary relations between them), frames (data structure for presenting a stereotypical situations).

The stages in the construction of expert systems can be systematized as follows:

- ***First stage - defining the task (problem)***

It is necessary the problem and the expected outcomes to be clearly defined. The method of solution is aslo included to this stage.

- ***Second stage – conceptualization***

The required knowledge are collected, presented and coordinated at this stage.

- ***Third stage – formalization***

The concepts must be expressed by frames or a programming language.

- ***Fourth stage– implementation***

Creation of a working expert system based on all the knowledge and procedures. A prototype program is developed. The constructing is a process that requires knowledge, software and integration.

- ***Fifth stage - testing***

The work of the program is evaluated based on its prototype. The authorized person is an expert in the particular field for which the expert system has been developed. The prototype can be reprocessed if some improvements are required.

There are different classifications of the expert systems depending on their purpose.

- ***systems for interpretation***

They describe a specific situation, using the information obtained through observations or sensors.

- ***systems for prediction***

They deal with the possible conclusions from the situation.

- ***systems of designing***

Different objects are introduced into the knowledge base. They meet specific criteria and are characterized by certain parameters.

- ***planning systems***

Their function is to induce the relevant activities that are needed for achieving a specific objective.

- ***monitoring systems***

They provide regular monitoring through observation and monitoring for possible problems that could impede obtaining a satisfactory outcome.

- ***debugging systems***

They are usually activated when the monitoring systems have registered a problem. These systems include methods for identification of errors and instructions for rapid and timely response in such situations.

- ***repair systems***

Their principle of work is similar to that of the debugging systems. The repair systems manage the overall process of removal of a problem.

- ***training systems***

As their name shows, these are systems that are designed to control the training process, minimizing mistakes made by the trainees in order to improve the quality and efficiency of education. These systems can be thematic, i.e. designed for a specific area.

- ***management systems***

They covered the entire process of control over a system, including forecasting, planning, surveillance and recording problems. Therefore, the management systems are widely used in the military sphere.

- ***diagnostic systems***

Diagnostic is carried out in the engineering sector in medicine. The engineering diagnostic is characterized by data entry related to technical problems and the result is a conclusion about the damage. The relationship between the military and medicine is very narrow, since a large part of the military positions are related to risky and life-threatening operations. Much of the the budget is provided for qualitative medical ensuring, because the health of employees is of paramount importance. There are so-called ***empty expert systems - nuclei (Ex-pert System Shells)***, that are programming environments with incomplete knowledge bases. An example of an empty expert system is EMYCIN, which was established in the U.S. (Stanford University) and is an independent version of the system for medical consultations MYCIN. EMYCIN is particularly suitable for establishing the diagnostic expert systems. Many symptoms, research results obtained in laboratory conditions and data must be entered in the knowledge base in order to get the maximum reliable diagnosis and be given competent advice regarding it.

2.3.4 Group Decision Support Systems

GDSS are multicriteria group systems that support decision making in order to improve the group process. GDSSD is an interactive computer-based and advanced DSS (Decision Support System) in terms of hardware, software, means of communication techniques for discussing the problems and their solution by a group of specialists that work as a team. The principle of functioning of DSS is based on quantitative and graphical models, as the data analysis is performed by special modules. Its components are:

- ***database;***
- ***base models;***
- ***user interface.***

DecisionLab is an example of application software for decision support.

GDSS is very effective in making strategic decisions and for interpreting the mission. The meeting is held in a specially equipped conference room and is suitable for both direct dialogue discussions and teleconferences. Teleconference comprises three types of conferencing technologies: audio, data and video. Except audio signal, videoconference uses cameras, suitable multimedia displays and software for “face to face“ visual communication.

It may be performed at two levels:

- ***large scale teleconferencing*** – it is conducted in large organisations that have specialized halls and prepared in advance websites for the implementation of this type of conference. This type of communication requires: cameras (one or more in order to more viewpoints and visibility among the participants); wide angle screens providing 3D visualization; audio equipment; maintenance personnel and high quality Internet signal.
- ***desktop teleconferencing*** – is uses PC and software. The advantage of this technology is saving funds for the equipment of a hall, but the cost increases if it is needed many users to be connected to Internet. It is necessary a computer with multimedia capabilities (sound card, video card, speakers), a camera and a microphone, as well as a good Internet connection. Microsoft NetMeeting® or Cu-SeeMe of Cornel University is is a specialized teleconference software that could be used. Netscape’s Cooltalk is suitable for audioconference only and it is not considered for this reason, because the focus of this material is on videoconference.

Both described methods are effective for international communication. Advanced technologies make it possible this type of cooperation to be quick, easy and useful.

The tasks of decision making can be combined into the following three classes:

- **multicriteria tasks** – they are divided into:
  - ***tasks of multicriteria optimization -*** they are defined by a finite number of specified functions. There are an infinite number of alternatives for this type of tasks.
  - ***tasks of multicriteria analysis -*** a finite number of alternatives are given in tabular form but there are many criteria and practically there is no an alternative to meet them all. It is necessary to be selected an optimal alternative to satisfy as much as possible criteria.
- **tasks in terms of risk** – it is very important the risk to be assessed and taken into account in planning for prevention purposes.
- **tasks in terms of uncertainty** – as the name itself suggests, in these tasks the factor uncertainty prevails and the decision should be made on the basis of the percentage uncertainty. It can be a result of a lack of reliable information.

The need of group discussion of issues that relate to the decision making is common between the three classes of tasks. This is an important stage of the operational planning in the military sphere. The methods that are used to group solving multicriteria tasks are:

- ***Priori methods*** – the group works as one unit of a hierarchy.

- ***Posteriori methods*** – the individual opinion of each participant is important that can be compared to a vote. Text chat is available and visible for all participants in the session during the interaction of the decision maker to the system. This allows informal communication needed for the discussion between the participants to solve the problem. The defining of the problem is a group process and relevant alternatives shall be entered

for each criterion. Each participant is free to choose a method for solving the problem by introducing the information about it in the system and thus receives an arrangement (decision). Usually the results are sent to the server via an interaction between the participants and the system. The server displays one of all decisions and send it back to them (feedback).

The method of aggregation "borda score" is the following. If the possible alternatives are m, then each decision-maker must put an assessment m-1, m-2 .... 1 for the alternatives that are accordingly in the first, second ... last place in the arrangement. The vectors of these assessments taken by all decision makers are summed. The resulting vector contains the aggregated score of the alternatives. The alternative with the highest score is the final result[27].

- ***Interactive methods*** – suitable for tasks with large numbers of alternatives. The interactive method CBIM (Computer-based Interactive Multimedia) is intended for solving tasks with many alternatives and a small number of criteria. The decision maker sets their preferences with greater security and accuracy. The advantage of this method is that the decision maker can control the process of searching for the most preferred alternative by selecting from a set of currently arranged alternatives. The main advantage of the method is the reduced load on the decision maker since the process of solving the problem is divided into steps[28].

An interesting interactive methods are:

- **GCBIM-bee** - there is no a leader in this model. The objectives of the group are the same and the members have different perceptions of how the objectives to be achieved. The group works in steps and each member can move among several points in the space of alternatives, using CBIM method and then makes a selection, voting for an alternative.
- **GCBIM-bee 1** - each participant selects an alternative for which to give his voice and it shall be sent to the server. The alternatives that have "low" borda-score are excluded. The process continues until the number of other alternatives falls below a set threshold and the alternative that has the highest borda-score is selected.
- **GCBIM-bee 2 –** the difference between this and the previous method is that if the number of "open" alternatives reaches a certain threshold, then it should move to the final iteration. The selection must be made among the "open" alternatives.

- ***weighting methods*** – the priority of the criteria is decisive as the objective is the most preferred alternative to be selected. The criteria are compared in pairs to a fixed scale that makes the method convenient and easy. Its disadvantage is that the decision maker has no right to set preferences.

The weighting method AHP (Analytic Hierarchy Process) is not applicable when the criteria are too many, because in this way the number of pairs also increases and this complicates the process of calculation.

[27] Andonov, Filip. „Interaktiven metod za grupovo vzemane na reshenia." www.instrumentation.hit.bg/. н.д. http://instrumentation.hit.bg/Papers/2008-02-09 FAIterative.htm

[28] „Metodi za grupovo reshavane na zadachi na mnogokriterialnia analiz." www.iict.bas.bg. 2012. http://www.iict.bas.bg/konkursi/2012/F_Andonov/Filip Andonov avtoreferat.pdf

There are specialized systems and software for videoconference. Some very good videoconferencing systems are:

- ***Life Size Room 220*** is a leading product of HD videoconferencing industry that can exchange 1280x720 pixels video content in real time at 30 frames per second. The system has an open architecture and proven interoperability.
- ***Life Size Mirial Softphone*** is a separate professional software client for videoconferencing that does not require use of a server. It is suitable for any PC or laptop, allows “point-to-point” connectivity and simultaneous connection between three points. It is compatible with Windows and Mac OSX operating systems and it is characterized with full HD resolution and best sound quality.
- ***Microsoft NetMeeting*** is suitable for audio and video conference of the type “point-multipoint”, providing the services text chat and data transfer.
- ***HP Sky Room*** – unique in its kind tool for videoconferencingthat offers real-time collaboration for four persons in a standard business network at an affordable price. Elements of this innovative video communication technology have been used by NASA's Mars rovers for transmission of high-resolution images to the Earth. SkyRoom lets users to share any application on a computer or a workstation, including office documents, videos and 3D images and provides interactivity.

A new model robot AVA 500 by iRobot and CiscoTelePresence is expected to come into use in 2014. It is specially for video collaboration, and was presented for first time at InfoComm 2013 show in Orlando, Florida. The main characteristics of the laser scanners were reviewed in the previous section, as the focus was on some of their applications in security and defense. The principle of functioning of AVA 500 is based precisely on laser scanning, because the robot has a built-in scanner. The robot has great potential for mobile visual access to production halls and facilities, experimental laboratories and institutions from distance. iRobot uses Ava mobile robotics platform as a base for the creation of Ava 500, improving it by the implementation of the personal video station EX60 of Cisco TelePresence and mounting a 21.5-inch HD screen EX60 on the mobile robot. The remote users can manage Ava 500 through the interface of iPad, locate themselves on the map, choose a room or an user name. Then, the robot realizes video conferencing. The user can make a tour from the station to the selected location mode "private" (the screen remains black) or alternatively "public", which means that the visual contact has been realized on both sides[29].

In 2011, Apple applied for a patent related to development of an innovative technology for creating a special unified LIDAR sensor emitting laser pulsations that are reflected from the surface of objects in the image, and they recognize the reflected signal[30]. It has a great opportunities to take pictures, video and 3D stereoscopic images, face recognition and their movements expressing a specific human emotion. It is possible the the position of the user's head and the direction of his gaze to be controlled by using a 3D camera. All changes can be interpreted as control commands. The concept of the new system for 3D forming and display of information (Three-Dimensional Imaging and Display System) has many similarities with Microsoft Kinect. This software-hardware complex is considered to provide interactivity, ie determining the position of the

[29] Computerworld. Ava 500 e noviat robot za videosatrudnichestvo na iRobot i Cisco TelePresence. 16 06 2013 r. http://computerworld.bg/43845_ava_500_e_noviyat_robot_za_video_satrudnichestvo_na_irobot_i_cisco_telepresence

[30] Kolegov, Ivaylo. Apple patent describes a great 3D camera. 2012. http://kolegov.blogspot.com/2012/04/apple-3d.html

user in the virtual environment and its direct interaction with the objects on the computer screen by hand movements in space.

The creation of a 3D model is a part of the planning process and after that it can be continued directly to the process of manufacturing, using 3D printing. It makes it possible to be created not only models and prototypes, but also completely practicable details in different sizes, made of special materials. It is a good practice, if experimental tests are needed.

2.3.5 Wireless Multimedia Sensor Networks

Wireless sensor networks (WSN) are used to collect information from the environment that is processed then transmitted to nearby or distant stations. They measure scalars like temperature, humidity, and pressure. They consist of wireless sensors that are composed of: mini battery powered video cameras; a low-power wireless receiver; a transmitter for processing, sending and receiving information. The sensors can collect audio and visual information using a special modules. WMSN can store and process the obtained multimedia information in real time.

The applicability of this type of networks is related to:

- ***monitoring and observation***

In fact the sensor networks have great opportunities for monitoring the parameters of various environments and observation of regions, private parcels and borderlines. Therefore, they are suitable to be used for different purposes in the field of security and defense and are also useful to law enforcement institutions.

- ***automation of the premise***

It is about equipment for a special premises of the type “smart home”. They are special automated systems and are one of and are one of the contemporary applications of communication and information technologies in various spheres of life. They may have a system of connected intelligent devices that perform a variety of functions. This system is called system for monitoring, management and overall control and includes:

- devices for measuring vital indicators;
- devices for control of the environment;
- sensors and identifiers for movement and action;
- communication devices;
- devices for performing information activities;
- devices for video monitoring[31].

It is necessary to make a distinction between "smart house" and premises of this type, but used for other purposes. While a "smart house" can be used in everyday life to make life easier for the elderly or disabled, the equipped with sensor networks automated premises may have a number of other applications.

[31] Boyanov, Liuben. „Savremennite informatcionni tehnologii v doma.“ www.smarthomesbg.com. н.д. http://smarthomesbg.com/files/lb_modern-its-at-home_unwe_3_4_oct_2013.pdf

Sensor networks are widely used in telemedicine as their main advantage is that the information can be transmitted over long distances. These networks are indispensable in a real combat situation when there are many life-threatening factors. The representatives of a risk group are under constant supervision even from a distance by an attached to the wrist medical sensor, measuring the main vital indicators: blood pressure, body temperature, ECG, breathing. The information is transmitted to remote medical centers that monitor their patients through audio and video sensors, motion sensors and etc. Once the incoming data be processed, should be made a diagnosis. If the process is fully automated, it is done by an expert system for diagnostic.

- ***localization of people***

Multimedia data, such as video streams or still images, together with advanced methods and techniques for signal processing, can be used for detecting missing persons or for the identification of criminals.

- ***industrial process control***

Various multimedia data together with measurements of various physical scalars (mass, temperature, pressure) can be used for quality control of the end products. The automation of these processes is needed, because the efforts and time must be optimized, but at the same time the quality to stay high, contributing to higher efficiency.

WMSN should meet some requirements for achieving maximum efficiency:

- ***high quality of service (QoS)*** – it is needed a hardware to maintain high level algorithms and ensure application performance.
- ***energy consumption*** – the sensors are loaded with batteries. It is necessary to be developed protocols, algorithms and architectures to make the life of the network prolonged, providing high quality services QoS at the same time.
- ***high channel capacity*** – high-speed transmission with low energy consumption is required for the streaming multimedia.
- ***encoding of the multimedia source*** – the data must be compressed.
- ***processing of multimedia information*** – this is performed by algorithms for processing of the information received initially. New and flexible architectures are required in order to be processed the information received from the environment in the network. It is necessary the information to be filtered in order to be reduced transmission of redundant information and other shortcomings.
- ***Integration with Internet (IP)*** – through a gateway for integration between WMSN an Internet, because it is not possible technologically all sensor to use IP[32].

The premises of type "smart home" can be modeled and simulated in a virtual environment in advance by using specialized software to satisfy the above requirements. This would help to be created a basic realistic 3D model of the room that can be gradually improved according to the needs and the established critical points in a result of the preliminary simulations.

[32] Tconev, Ivan, и Stanimir Stanev. Kompiutarni mreji i komunikatcii. Shumen: University Publishing "Episkop Konstantin Preslavski", 2007.

2.4 SPECIFICATIONS OF THE APPLICATION IN SECURITY AND DEFENSE

The protection of information is mandatory to varying degrees for all areas, but it is extremely important in the sphere of security and defense, due to the need for a high level of protection of classified information. This requires the transmission of information by secure channels. Considering that the practical part of the paper is related to video conferencing, it is necessary to be paid attention to the possibilities for the protection of the transmitted data.

A special channel that can be used only by authorized persons is organized by using IRC (Internet Relay Chat) technology. IRC is a protocol for Internet chat or synchronous conference. It is mainly designed for a group communication in discussion forums, called channels. The interlocutors are separated into rooms (chat rooms) that are serviced by chat servers. The communication is between many people in real time at the same moment ("many-to-many") and this makes it fundamentally different compared to ICQ, Skype, MSN Messenger and other services for communication between two people ("one-to-one"). Usually a short delay (0.5 to 2-3 seconds) is registered between sending a message and the receiving by the interlocutor (lag). IRC provides an opportunity for communication between two persons (“one-to-one”) by private messages, as well as data transfer, but its strength is the communication between many people.

The transmission medium may be different depending on the number of correspondents. This determines the type of the conference:

- ***Point to Point*** – between two systems (Terminal 1 and Terminal 2) via Internet. The connection is accomplished most often by an IP address.
- ***Point to Multipoin)*** – connects three or more systems, i.e. the transmitter is one, but the receivers are fixed number (conference call).

VPN (Virtual Private Network) enables remote access with preservation of the quality and integrity of the output information. Usually they are built on the network layer of the OSI model and use IP as a network protocol. IP VPN is a service that aims to meet the needs of corporate business, ensuring high quality, security and great possibilities for integrated transmission of data, voice, video and multimedia[33].

A tunnel is constructed to transmit messages via Internet in VPN. It is done by creating a logical connection between two end points, maintaining authentication and data encryption between them. “Tunelling” means three main processes – capsulation, decapsulation and routing packets. In encapsulation the original package is hidden in a new one that is used for routing through the tunnel. The address of the endpoint of the tunnel is set in the header of newly created package and the address of the node - recipient is located in the header of the original packet, which remains encrypted until receipt at the end point of the network.

Основните изисквания, които виртуалните частни мрежи трябва да удовлетворят, са свързани с прилагането на следните общовалидни критерии за сигурност:

- ***identification and authentication*** – users are required to prove their identity and status in an organization in order to obtain a right of access to relevant information;
- ***management of addresses*** – appointment of VPN clients at an Intranet address and providing addresses used on the Intranet;

[33] Penev, Nikolai. Savremenni komunikatcionni sistemi i tehnologii. Sofia: Publishing House "Vanio Nedkov", 2008.

- ***data encryption*** – it is a part of the process for ensuring data protection in their transfer through the Internet. The protocol IPsec is used to encrypt the data passing through a tunnel, built by another VPN protocol. It works at the network level and ensures the integrity, authenticity and confidentiality of the data. TLS (Transport Layer Security) and its predecessor SSL (Secure Sockets Layer) are cryptographic protocols providing communication security in Internet. TLS and SSL encryption are segments of network connections over the transport layer and use asymmetric cryptography.
- ***key management*** - keys must be generated and periodically updated.

Conclusions:

1. Multimedia and communication technologies are closely connected.

2. Multimedia technologies are used in different forms in the performance of military tasks associated with simulations and visualizations.

3. Different options for the use of multimedia technologies in the field of security and defense are discussed - in GIS; simulators; in the artificial intelligence systems and expert systems; in GDSS; in wireless multimedia sensor networks; for training.

4. The advantages of using multimedia technologies in the field of security and defense are discussed:

- for realistic simulations and visualizations;
- for preparation, presentation and analysis of data (voice, video, etc.).
- supporting the processes of command and control.

5. The advantages of VPN are described in terms of security requirements.

APPENDIX

RENDERED IMAGES OF 3D MODELS

The Appendix contains examples of rendered images of 3D models by the author, created with specialized software and designed to show the the extensive array of computer graphics for use in various fields.

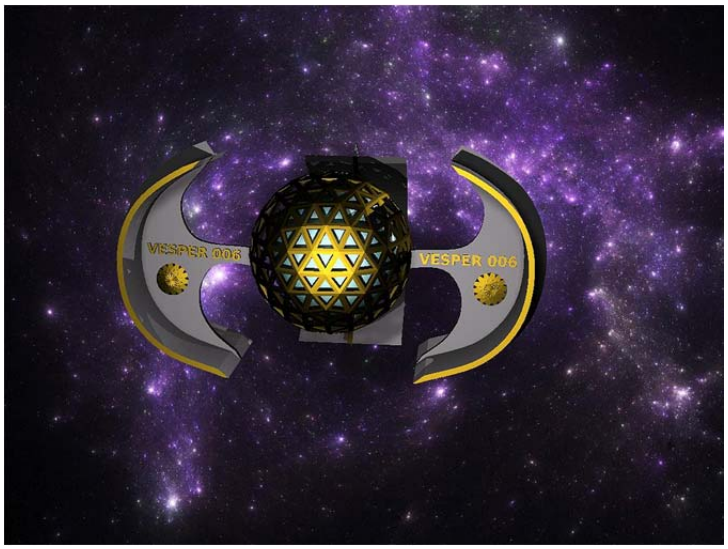

Figure 1. A conceptual model of a spherical robot created in 3DS Max.

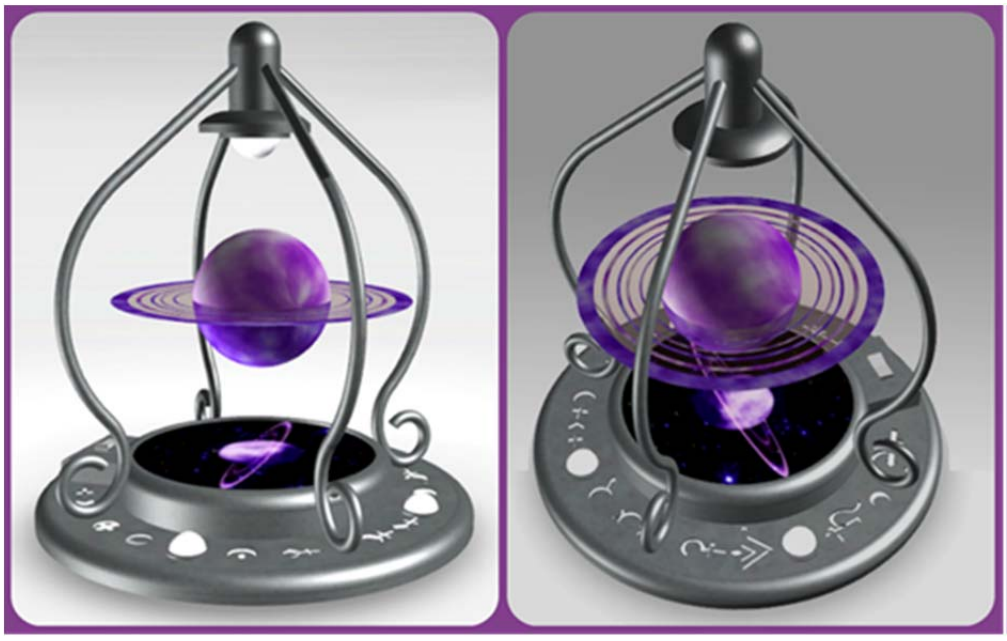

Figure 2. A 3D model of levitating Galieleo Gravitator created in 3DVIA Shape.

Figure 3. Model of character in different fighting positions created in DAZ Studio, suitable for importing into a simulation game.

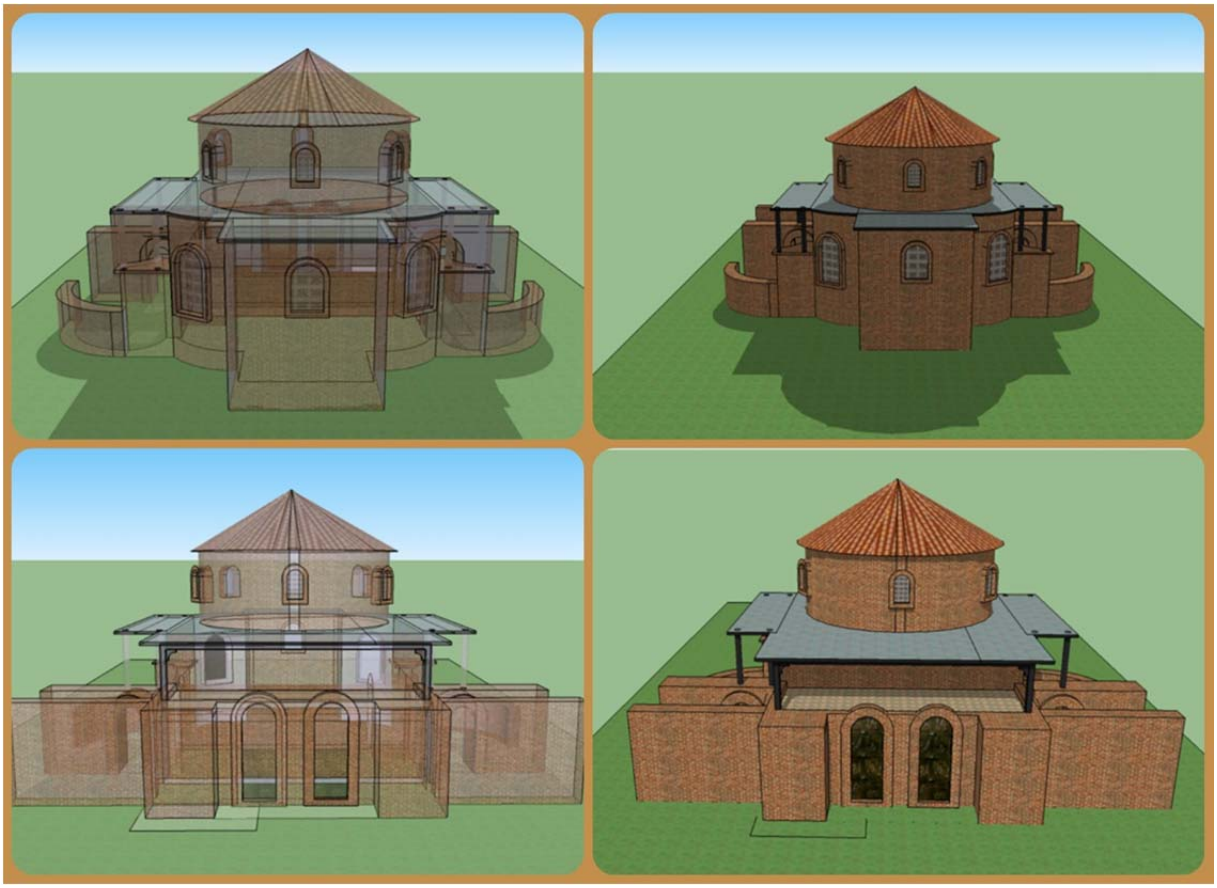

Figure 4. Model of the Rotunda "St. George", created in Google SketchUp.

BIBLIOGRAPHY

1. Andonov, Filip. „Interaktiven metod za grupovo vzemane na reshenia.“ *www.instrumentation.hit.bg/*. н.д. http://instrumentation.hit.bg/Papers/2008-02-09FAIterative.htm

2. „Metodi za grupovo reshavane na zadachi na mnogokriterialnia analiz.“ *www.iict.bas.bg*. 2012. http://www.iict.bas.bg/konkursi/2012/F_Andonov/FilipAndonovavtoreferat.pdf

3. Arsenov, Anton. „Virtualnoto boino pole s kliuchova rolia v razlichni aspekti na voennoto obuchenie.“ 2007. http://cio.bg/1534_virtualnoto_bojno_pole__s_klyuchova_rolya_v_razlichni_aspekti_na_voennoto_obuchenie.

4. Boyanov, Liuben. „Savremennite informatcionni tehnologii v doma.“ *www.smarthomesbg.com.* н.д. http://smarthomesbg.com/files/lb_modern-its-at-home_unwe_3_4_oct_2013.pdf

5. Computerworld. *Ava 500 e noviat robot za videosatrudnichestvo na iRobot i Cisco TelePresence.* 16 06 2013 г. http://computerworld.bg/43845_ava_500_e_noviyat_robot_za_video_satrudnichestvo_na_irobot_i_cisco_telepresence

6. *DirectX 11.* н.д. http://windows.microsoft.com/bg-bg/windows7/products/features/directx-11

7. *Flight simulator.* 2011. http://en.wikipedia.org/wiki/Flight_simulator

8. *GeoShow3D Lite.* н.д. http://geoshow3d-lite.software.informer.com/

9. *GIS, Photogrammetry and Cartography.* н.д. http://www.metrisys.com/category/products/gis-mapping-systems/

10. „High-tech software solutions from ESRI Bulgaria.“ *www.esribulgaria.com.* н.д. http://esribulgaria.com/wp-content/uploads/2013/07/2.7.1.Brochure_ENVI1.pdf

11. Ivanova, Yoana, и Stefka Nenova. *Computer graphics as a means of improving the quality of military education.* Sofia: Publishing House of Military Academy, 2013.

12. Koeva, Mila. „Holography - principles and applications in photogrammetry.“ *www.milakoeva.weebly.com.* 8 11 2002 http://milakoeva.weebly.com/uploads/7/3/2/0/7320208/holography-mila.pdf

13. Kolegov, Ivaylo. *Apple patent describes a great 3D camera.* 2012. http://kolegov.blogspot.com/2012/04/apple-3d.html

14. „Koraben simulatcionen trenajor.“ *www.new.tu-varna.bg/* . 2011. http://www.tu-varna.bg/tu-varna/images/stories/Novini/Valia/3/PREZENTACIA_TRENAJOR.pps

15. Lazarova, Stoyanka. „Izpolzvane na interactivnata multimedia v obuchenieto.“ Veliko Tarnovo: University Publishing "St. Cyril and St. Methodius", 2010.

16. Martini, Gloria. *STACCATO - STAkeholders platform for supply Chain mapping.* AeroSpace and Defence Industries Association of Europe, 2006.

17. Mevassvik, Ole Martin, Bråthen Karsten, и Richard Moe Gustavsen. „JADE – An Experiment in Distributed Simulation Based Joint Tactical Training.“ *http://www.cso.nato.int/*. н.д. http://ftp.rta.nato.int/public/PubFullText/RTO/MP/RTO-MP-MSG-045/MP-MSG-045-18.pdf

18. Milev, Georgi. „Lazerno i radarno skanirane.“ *www.geodesy-union.org*. 2012. http://geodesy-union.org/images/GKZDATA/lazer-radar-scan-milev-01.pdf

19. Nenova, Stefka. „Multimedia Systems. Lectures.“ *www.tuj.asenevtsi.com.* 2013.

20. Panayotov, Dimitar. *3D printiraneto i prilojenieto mu v sferata na sigurnostta.* 15 01 2014 г. http://www.security.bg/topnews/3d-printiraneto-i-prilozhenieto-mu-v-sferata-na-sigurnostta

21. Penev, Nikolai. *Savremenni komunikatcionni sistemi i tehnologii.* Sofia: Publishing House "Vanio Nedkov", 2008.

22. Petrova, Vanya, и Mila Koeva. „Digitalna fotogrametria v GIS.“ *http://milakoeva.weebly.com/*. н.д. http://milakoeva.weebly.com/uploads/7/3/2/0/7320208/gis_sofia.pdf

23. Rachev, Valeri, и Zlatogor Minchev. „Metodika za razrabotvane na stcenarii i kontekstni stcenarii za otbranitelno planirane.“ От *Metodologia i stcenarii za otbranitelno planirane*, от Ministry of Defence. Directorate "Defence Policy". Military Publishing, 2007.

24. Tagarev, Todor. „Metodologia i situatcionni stcenarii za planirane na otbranata i vaorajenite sili.“ От *Metodologia i stcenarii za otbranitelno planirane*, от Ministry of Defence. Directorate "Defence Policy". Military Publishing, 2007.

25. Tagarev, Todor. „Organizatcia na nauchnite izsledvania v interes na otbranata.“ *Military problerms*, 2001.

26. Tconev, Ivan, и Stanimir Stanev. *Kompiutarni mreji i komunikatcii.* Shumen: University Publishing "Episkop Konstantin Preslavski", 2007.

27. *Universalen simulator ot Avstralia.* 2011. http://fakti.bg/technozone/23157-universalen-simulator-ot-avstralia (отваряно на 2013).

28. „Upatvane za aerofotosnimane.“ *www.theplan.net*. 1993. http://www.theplan.net23.net/14N16.pdf

29. *Virtual Realities Products.* н.д. http://www.vrealities.com/product

30. „White Paper on Defense and the Armed Forces of the Republic of Bulgaria.“ *www.mod.bg*. н.д. http://www.mod.bg/bg/doc/drugi/20101130_WP_BG.pdf

31. Илиев, Михаил, и Йордан Александров. „Анализ на безжични мултимедийни сензорни мрежи.“ *www.conf.uni-ruse.bg*. 2010. http://conf.uni-ruse.bg/bg/docs/cp10/3.2/3.2-7.pdf

32. *Продукти.* н.д. http://www.esri.com/products

33. Рачев, Валери, и Златогор Минчев. „Методология и ситуационни сценарии за планиране на отбраната и въоръжените сили.“ н.д.

34. *Уникална 3D камера ще отличава бъдещите iOS устройства.* 2012. http://www.digital.bg/novini/