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DISTRIBUTED CAX AS A MODERN FORM OF COMMAND AND STAFF TRAINING

Abstract. The JTLS (Joint Theatre Level Simulation) simulation system, used for 10 years in the War Games and Simulation Centre, National Defence University, Warsaw, enables conducting computer-assisted command post exercises. The article describes operational possibilities, terrain model and user interface in the JTLS system. The authors also describe the classification of computer simulation and attempt to define the distributed computer assisted exercise. Organisational aspects, technical problems and issues connected with the interoperability of different simulation systems and C4I systems are dealt with in the context of conducting CAX.

Keywords: computer simulation, training, distributed CAX, JTLS.

1. COMPUTER SIMULATION IN MILITARY TRAINING

Computer simulation is now used by the armed forces of many countries, where it constitutes an important component of command and staff training. The commonness of this training method is supported by the fact that both globally, and in the Polish Armed Forces, there are categories of command post exercises that are computer assisted (CAX - Computer Assisted Exercise). Computer assistance in such exercises consists in the use of battlefield simulation systems.

Such systems are primarily designed to model the effects of tactical (theatre) operations conducted by at least two opposite parties and "anticipation" of the results of the interactions between the parties by comparing their relative potentials. Additionally models take into account the impact of other factors that are important from the military point of view, such as weather or visibility, and of the terrain model. Decisions developed by the commands participating in the exercise are input into such systems in real time, and the simulation results are communicated to the trainees. The most important role of the battlefield simulation system is to substitute the subordinate troops that are non-existent in the exercise and to represent their actions based on the tasks assigned by the exercising staffs. In computer-assisted command post exercises the functions of exercising troops and response cells are taken over, completely or in part, by the simulation system and its operating personnel.

The advantages of exercises organised and conducted in this manner include:

- ability to "play free" instead of providing ready recipes (formulas) for solving defined situations, which significantly increases realism;
- alternative manner of conducting training courses and exercises without the need to deploy real military units in the training grounds; this implies reduced cost of such exercises;

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- teamwork support, resulting from the fact that the working environment is common to all process (exercise) participants, and that the actions of each participant are evident to the other participants;
- flexibility in adapting scale and content that are subject to simulation;
- broad opportunities for participation in simulated processes irrespective of geographical distance separating the participants.

2. DISTRIBUTED CAX

There are three categories of military operations simulation:

- Constructive Simulation – computer models which represent operations of people and equipment. This category includes simulation systems for conducting "wargames", which model military (tactical) operations and the outcomes thereof in real time.
- Virtual Simulation – real humans operate devices (simulators) that simulate defined personal equipment, vehicles, aircraft, etc. This is usually applied to familiarise with the operation of equipment (vehicles) prior to using them in real environment.
- Live Simulation – real humans (soldiers) operate real equipment and materiel attached to simulated environment. An example of such simulation is the use of laser devices that are mounted onto real weapons to indicate hits during shooting exercise.

From the viewpoint of command post exercise the most useful method of conducting training is to use constructive simulation. Simulation systems based on this category of simulation enable interacting with the simulation model, forcing the trainees to make decisions in real time and verifying these decisions by producing the effects of implementing them. In addition, these systems are provided with interfaces that enable data exchange with other simulation systems of the same or other simulation category.

Of particular interest is also the fact that manufacturers of simulation systems put increasingly more stress on the construction of modules that enable data exchange with C4I systems (Command, Control, Communications, Computers, and Intelligence). This enables transmitting the dynamic image of the battlefield to command and control systems that are becoming standard component of command and staff equipment. This situation is the implementation of the principle that is followed not only in the Polish Armed Forces, and which says: "train as you fight".

In countries with long tradition of using simulation systems in training, principally in USA and Germany, the term CAX is usually applied to such computer assisted exercise where all, or at least two categories of simulation are used. This is related to the extent of the conducted exercises, where in one exercise constructive simulation is used mainly by commands and staffs, whereas virtual and live simulation is used for the training of crews, operating personnel and for improving individual skills of soldiers. However, along with the development of simulation systems that use constructive simulation, classes of simulation systems began to be created for application at various levels (theatre and tactical). The effect of "dispersed" information processing in the category of constructive simulation is at present attained by bringing about the exchange of information between two (or more) simulation systems, wherein each of the systems "produces" battlefield image adequately to the needs of the corresponding level.

If in these considerations we take into account the fact that automated military command and control systems also process and distribute among subordinates the information provided by the simulation system, and the fact that such collaboration may be effected with the use of wide area networks, then this may be the basis for defining dispersed exercises.

Taking into account the specificity of the Polish Armed Forces, *distributed CAX should be defined as a computer assisted exercise where for the purpose of conducting simulation and processing combat information an environment comprising at least two simulation systems or comprising a simulation system and an automated command system is used, and where both systems are able to operate in a wide area network enabling participation in the exercise of entities at geographically distant locations.*

3. CONDUCTING DISTRIBUTED CAX IN THE POLISH ARMED FORCES

The armed forces of many countries, including those of Poland, set up special dedicated facilities appropriately designed and prepared for conducting computer assisted command post exercises. The Simulation and Computer War Games Centre (CSiKGW) was established by the Polish Armed Forces as a result of the increasing importance of the role of ICT systems in both the training process, as well as in conducting combat operations. Battlefield simulation is perceived as a tool which helps the commanders and other decision makers to understand the processes that occur in the modern battlefield and to be better prepared for them. CSiKGW has been conducting CAX since 2006. Exercises are conducted with the use of an interactive simulation system that models the operations of joint forces – JTLS (Joint Theatre Level Simulation).

JTLS has been expanded and improved for many years now. The first concepts and designs appeared in 1982. JTLS is an interactive simulation system that models the operations of army, air force, navy, and special forces. It reflects the key war aspects with account taken of non-military entities. The system is manufactured by Rolands & Associates Corporation. The system is designed for analysing, designing and evaluating operation plans, for evaluating alternatives (combat operation options) and for analysing the structures of combat units with account taken of combat systems. At CSiKGW the system is used to conduct computer assisted exercises by applying combat operation models to create an operational computer environment for decision-making entities, wherein that environment resembles the one that these entities are likely to encounter on the battlefield.

3.1. Operational capabilities of JTLS

JLTS enables creating up to 10 force sides, and each side can be divided further into an unlimited number of force sub-groups, called factions. The operations of units of the same branch of armed forces (army, air force, navy, special forces) or of the same type of troops (mechanised, armoured, chemical, engineering, logistic, etc.) can be modelled as factions. Also non-military entities can be modelled, e.g. groups of refugees. Relations between force sides can be asymmetric and can be modified by exercise participants during the game, depending on the needs and the scenario.

The exercise participants interact with the simulation by sending orders to virtual units commanded by them. The chain of command is defined at the stage of data base creation. Each of the force sides defined in the game is positioned in relation to the other sides as: friendly, neutral, suspect or enemy. Force side relationships determine how units react to units of other

sides, e.g. a unit destroys discovered objects (other units, convoys, transport means, etc.) only if its relationship is set as "enemy".

The concept of simulation in JTLS is based on the application of a number of partial models which define the scope of functionalities and the suitability of the model. Arms and military equipment and manpower are modelled within JLTS in the form of the so-called Combat Systems. In the current version of the system up to 100 combat systems can be modelled. Each combat system is described in terms of various characteristics, such as, for instance, maximum effective range, recoverability and repairability of damaged equipment, type of fuel and ammunition, etc., used during simulation. Combat systems are also classified as direct or indirect fire systems. JTLS also enables modelling of the effects of weapons of mass destruction.

3.2. Terrain representation

The basic unit of terrain description in JTLS is a regular hexagon (hex) (hexagon map). A single hex is characterised by a set of precisely defined parameters related to its surface or individual sides, such as:

- surface cover and configuration: open with good trafficability, open with limited trafficability, forest, forest with good trafficability, forest with limited trafficability, desert, desert with good trafficability, desert with limited trafficability, city, rubbled city, mountain, mountain with good trafficability, poor roads, ocean, small islands;
- terrain obstacles: river, fjord, gorge, antitank ditch, inaccessible area, sea coast;
- maximum land elevation;
- mean depth of oceans.

Exercises can be conducted on an area 2000 x 2000 NM (nautical miles) in size; 1 NM = 1852 m). The default size of a single hex is 7.5 km, 1 km wide hex's can also be used. The current version of the system enables the use of raster maps, which may be overlaid (as a transparent layer) on the hexagon map (see Figs. 1 and 2).

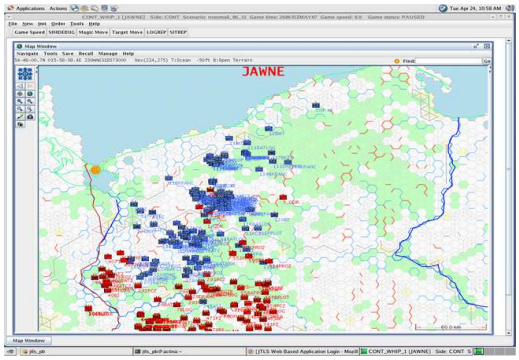

Fig. 1. Combat situation on a hexagon map

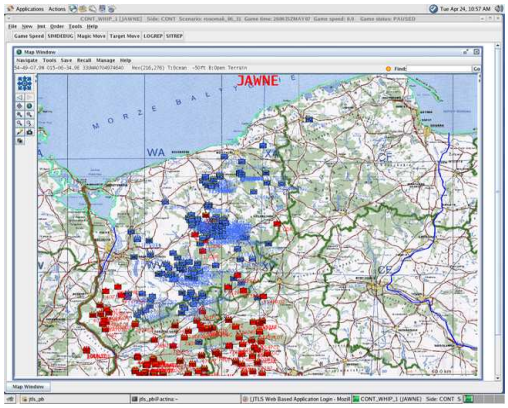

Fig. 2. Combat situation on a raster map

3.3. System user interface

JTLS user communicates with the system via an interface, which runs on a workstation. This interface works with the system via a Web browser. The basic functions of the JTLS interface, which is called WHIP (Web Hosted Interface Program), are as follows:

- graphical representation of the operational situation on the battlefield, with the option to filter elements to be displayed on the map;
- sending commands (orders) related to the conduct and course of simulation to the model;
- presentation of data of the simulation process in tables;
- receiving current information generated by the simulation model (in the form of text).

WHIP interface for JTLS user is shown in Fig. 3.

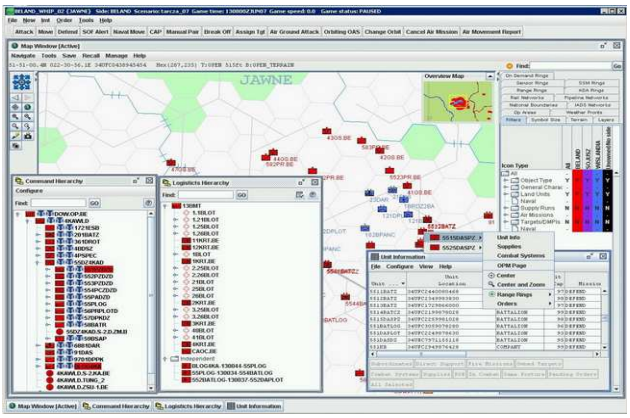

Fig. 3. WHIP interface of JTLS

The system is used by many NATO nations (e.g. Turkey, Spain, Italy), and also by other countries around the world (e.g. Australia, New Zealand, Taiwan). System users meet at conferences dedicated to exchange of experiences associated with conducting CAX. Currently there is a pressure to enable simulation systems to mutually exchange information and thereby enable conducting large distributed CAX. JTLS also follows this trend. Advanced work on

improving information exchange between JTLS and tactical level simulation systems has been conducted for many years.

4. EXERCISE EXECUTION CONCEPT

Distributed CAX can be executed using three elements:

- theatre/strategic level simulation system (JTLS);
- C2 class ICC (Integrated Command & Control) system;
- GESI (**GE**fechts (Warfare) **SI**mulation) tactical level simulation system.

From the point of view of the users of an ICT network (simulation system and command support system), operations in a wide area network are conducted in the same manner as in a local area network. Substantial differences are in the manner of making network connections between workstations and servers. This is due to the fact that wide area networks are usually heterogeneous, which means that they were constructed (and later expanded) using diverse technologies (older, followed by newer), using equipment from various manufacturers, resulting in varying performance, reliability, etc. The need to transmit data via WAN makes connection throughput between individual locations a critical parameter. These aspects have to be taken into account when planning the structure of an ICT network.

The manufacturer of JTLS facilitates the meeting of requirements for information exchange with other systems by providing a JOI (JTLS Operational Interface) application. This application enables feeding RAP (Recognised Air Pictures) image to automated command systems (including ICC, which is one of the basic tools used by the Polish Armed Forces and by the NATO Allied Forces). Information transfer is based on TADIL – J (Tactical Digital Information Link J) protocol – code name LINK 16 and NIRIS (Networked Interoperable Real-time Information Service) application. NIRIS stores current tracks, mainly of fast changing JTLS entities, to display them afterwards in ICC. JOI enables transfer from JTLS to ICC of such fast changing entities as airborne mission and ballistic missile paths. It is also possible to transmit data of airbases and of units deployed therein: air squadrons, FARP units, ground and logistic units, convoys and task groups.

Further components that enable interaction between JTLS and ICC include JTOI (JTLS Transaction Operational Interface*)* and ATO-T (Air Task Order Translator). JTOI is used for importing entities from JTLS directly to the ICC database. This is done automatically without any action required from the ICC operator. Upon importing the entities, the ICC operator is ready to create an ATO, the main air force order issuance document planned for a day of operations. ATO-T enables automatic ATO transmission and completion in JTLS, which the ICC operators are able to see on their workstations.

The principle of ICC and JTLS interaction is shown in the figure below (Fig. 4). In this case the essence of "distributed" information processing is the fact that ATO is created in ICC based on information provided from JTLS, after which JLTS implements directives (individual air missions) included in the order in an automatic manner.

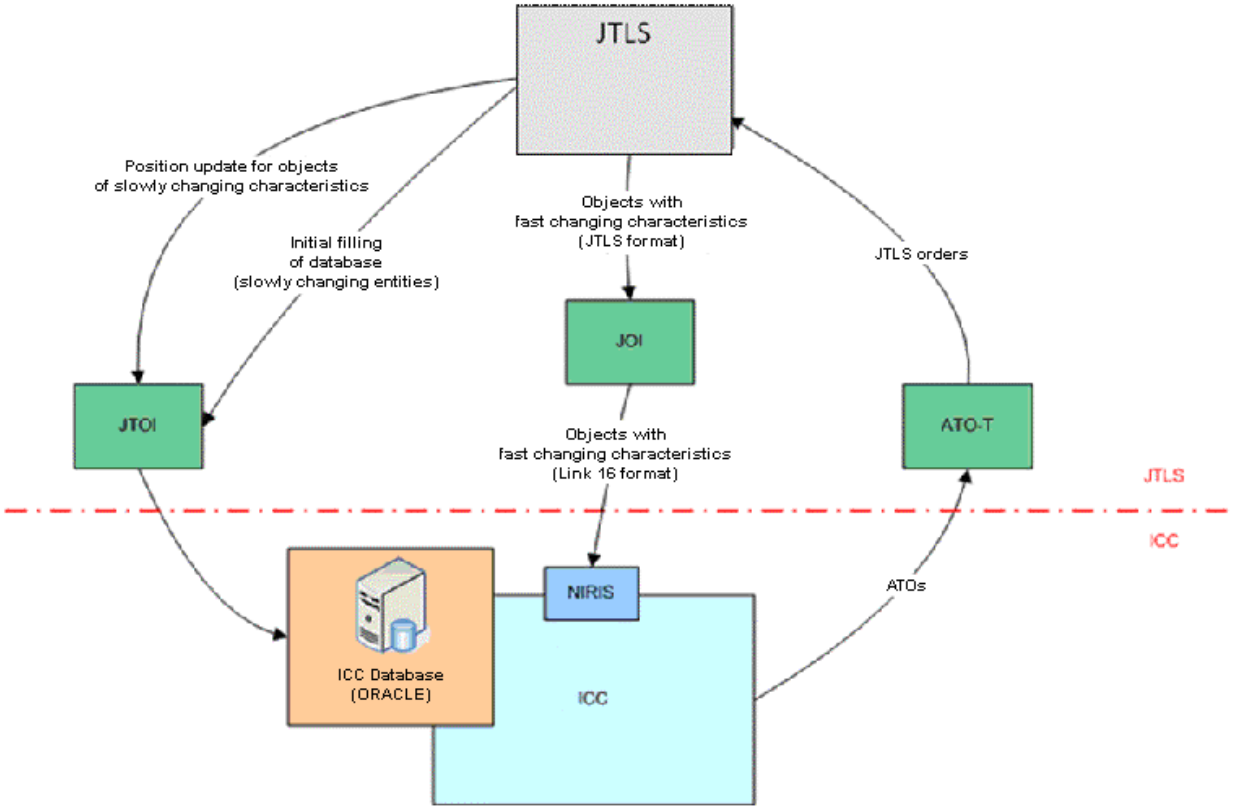

Fig. 4. JTLS and ICC interactions during CAX

Execution of a distributed CAX in the case of JTLS working with another simulation system, which is GESI, is based on other assumptions related to other needs. The effect desired here is to accomplish tactical episodes in CAX conducted at theatre level. This is also associated with the fact that at present assignment of units to defined levels is based on tasks fulfilled by them rather than on the size of the unit and its resources. This implies that units of the theatre level are also able to carry out tasks of the tactical level.

JTLS is equipped by the manufacturer with ELS (Entity Level Server) applications. This application disaggregates objects simulated in JTLS and, in liaison with JTLS communication server, sends the disaggregated objects to another system (in this case a simulation system of lower level). Both systems operate within High-Level Architecture (HLA), which is one of the standards applied when implementing distributed simulations, and using Run Time Infrastructure (RTI) software, which "ensures" object exchange between the systems.

The idea of JTLS and GESI operation under HLA is shown in Fig. 5.

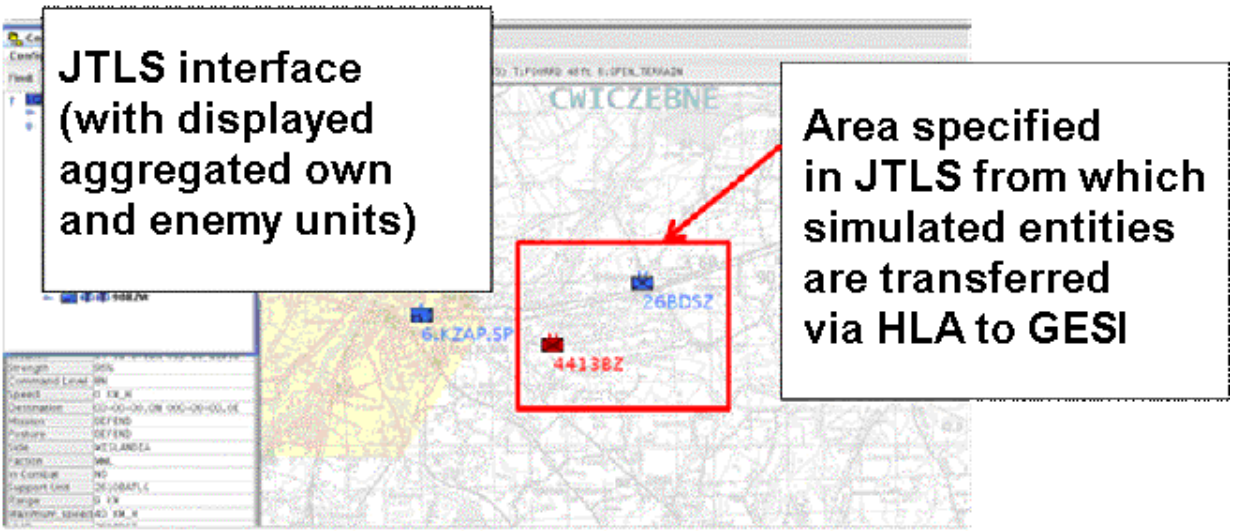

Fig. 5. JTLS and GESI interactions during CAX

When conducting simulation the objects to be transferred from JTLS to GESI are placed in a special dedicated area within JTLS. These are ground units (including special troops) and air missions. It is not yet possible to transfer maritime units and logistic convoys. In addition, the systems exchange information on damage caused by combat systems: air to air, ground to air, air to ground and ground to ground. JTLS may optionally control the simulation time elapsed for both systems.

5. CONCLUSIONS

The growing importance of CAX in the training of commands and staffs in the armed forces of NATO members is confirmed by the establishment of the Polish Simulation and Computer War Games Centre and, shortly afterwards, of the Joint Force Training Centre (JFTC) in Bydgoszcz. JFTC is provided with JTLS and with Joint Conflict and Tactical Simulation (JCATS) system, which in recent years was developed and extended to co-operate with JTLS, and with Virtual Battlespace 2 (VBS2). Such co-operation may be effected both during stationary exercises in a local area network, as well as using wide area networks that remain at the disposal of NATO and the Polish Armed Forces.

Tendency to use many simulation systems during one CAX is tantamount to the pursue by simulation system manufacturers to attain interoperability and with the drive during allied exercise towards the use by NATO countries of simulation systems that they use in the training of their national armed forces.

Apart from apparent benefits resulting from conducting such exercises, it must be stressed that carrying out these exercises on a regular basis involves substantial expenditures resulting from the need to:

- continually upgrade computer equipment used in the exercises;
- expand and upgrade computer networks used in the exercises;
- train ICT support teams in the operation and maintenance of increasingly advanced simulation systems.

Despite the requirements listed above, the significance of simulation systems and CAX conducted with the use thereof is growing. One may anticipate that in the future they will constitute an important link in the process of command and staff training.

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