NATO's Joint Warfare Centre Perspective on CAX Support Tools and Requirements

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1. INTRODUCTION

A computer assisted exercise (CAX) is a type of synthetic exercise (SYNEX) where forces are generated, moved and managed in a simulation environment. Therefore, CAX support is often thought limited to installing and running a military constructive simulation during a command post exercise (CPX). In this perception CAX support is to replace or to help response cells, high level commands (HICON), low level commands (LOCON) by running a set of stochastic processes to find out the possible outcomes of the decisions or requests coming from the training audience (TA).

However, a CAX is in essence a CPX where electronic means are used

- to immerse the TA in a realistic situation and environment,
- and to help the exercise planning group (EPG) and the exercise control staff (EXCON) for controlling the exercise process (EP) so that it achieves the objectives.

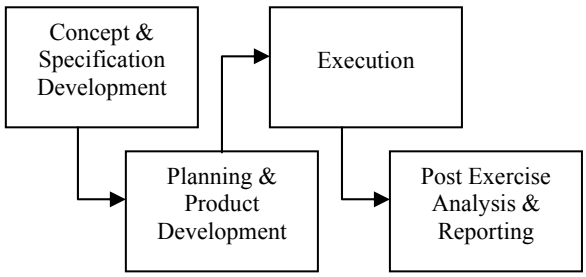

Figure 1. Exercise Process.

Therefore, CAX support is more than setting and running a military constructive simulation system. CAX tools should be involved in all stages of an EP depicted in Figure 1 to automate the processes, to reduce the duplication of work, to enhance the exercise environment, and to ensure that the EP flows towards the objectives. The CAX tools in this perspective can be categorized into four classes:

- Exercise planning and management tools: These tools can be used for the automation of processes, information management and information exchange for the preparation of the exercise specification (EXPEC) and exercise plan (EXPLAN) documents and the products related to these documents. They can help the preparation of scenario as well as the main events and incidents

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lists (MEL/MIL). They can also have interfaces for the CAX tools that fall in the other categories. Through these interfaces the data collected during the specification and planning stages can be directly fed into simulation as well as command and control (C2) software.

- Constructive simulation systems and ancillary tools: These are the simulation systems and the software needed to run the simulation, e.g., database preparation tools, user interfaces, etc.
- Interfaces to C2 and operational planning tools: Simulation systems should be transparent to the TA. Especially primary TA (PTA) should only use C2 systems that can be available during an operation. Therefore, interfaces between the simulation software and C2 systems are needed. Similar interfaces are also needed for the operational planning (OP) tools because they also need the data related to the exercise scenario.
- Experimentation and analysis tools: These are the programs used for designing and managing experiments by using CAX data and for compiling and presenting the data collected by the simulation system as well as deriving information from these data.

For the time being there are tools that fall in some of these categories in NATO. However, to the best of our knowledge, these categories are not fully filled yet. Moreover a web enabled and integrated software that automates all of the phases from exercise specification to the lessons learned phase, and can interact with simulation, C2 and OP systems would be much better than having separate systems for each item in the EP. In this paper we broadly define the requirements and components for such a joint CAX management system (JCMS). Please note that we concentrate on NATO CAXs, and develop the requirements based on the EP and tools available within NATO. Nevertheless, we think that our approach is generic enough to be adapted for the national requirements.

In the next section, we examine each category of CAX tools. We also list the systems that are available in NATO and fall in one of these categories in the same section. We briefly explain our preliminary ideas about JCMS in Section 3. Section 4 concludes our paper.

2. COMPUTER ASSISTED EXERCISE TOOLS

The EP for a CAX starts by developing exercise concept and specification. The officer scheduling the exercise (OSE) leads this phase. Exercise planning group (EPG) is activated, exercise objectives, mission priorities, missions and the essential tasks for the primary TA, the type and the form of the exercise are determined. Then these are stated in an EXPEC with the other details that will be needed during the exercise planning process. CAX support tools may support an EP starting at this early stage.

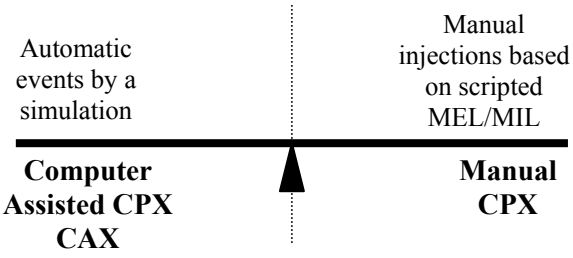

Figure 2. Simulation during a CPX.

2.1. CAX planning tools

During a CPX, the situation, the common operational picture and the injections can be generated automatically by a simulation system or created and calculated by the EXCON manually based on major events and incidents (MEL/MIL) lists. Between these two extreme cases there are hybrid approaches where manual means and simulation are used in conjunction as shown in Figure 2. Although that can be changed later during the EP, the broad decision for this, i.e., which simulation systems will be used to which extend in the exercise, should be taken before the approved EXSPEC is issued. At least, it should be decided whether a simulation system will be used or not. This decision is based on several factors including:

- Exercise training objectives,
- Missions and operational tasks,
- Capabilities and the availabilities of the simulation systems
- Constraints on the resources such as budget, time, space, man power and CIS capabilities

A software tool can provide a structured way to derive the training objectives, missions and operational tasks based on current documents such as training/exercise programmes, training/exercise directives and guides, lessons learned databases, the statements by the OSE, OCE and PTA Commander. Then this tool may compare the requirements with the capabilities of the available simulation systems, and can even figure out the required resources, e.g., man power, CIS infrastructure, the cost of simulation, etc, according to some additional parameters such as the level of exercise and the size and the number of component commands. Since the number of available simulation systems is often small and it is easy to decide on the appropriate system, this tool can be more useful in determining weaknesses of a simulation system and approximate cost of using them for a certain exercise.

After the EXSPEC, OCE issues the exercise planning guidance. The next key milestone in an EP is the promulgation of the exercise plan (EXPLAN). In the preparation of EXPLAN many exercise support products including the following are prepared:

- Road to Crises
- MEL/MIL
- Operational planning process documents
- Political resolutions
- Force activation/transfer of authority messages
- Intelligence products
- Friendly/Enemy order of battle (FOB/EOB) databases
- Geographical information system databases
- Operational plans

Many of these are parts of a scenario made up of modules which can be further decomposed into sub-modules depicted in Table 1. A new scenario can be developed by carefully scrutinizing and merging available off the shelf sub-modules shown in Table 1. For example, geography can be selected from the generic or real exercise geography databases, and modified according to the specific needs of an exercise. Then country books can be selected from the shelf, massaged according to the needs and merged with the geography.

A tool that is in line with the EP can automate this, and reduce the cost of the scenario products. Please note that various scenario modules related to each other are prepared during different stages of the EP by different staff members. For example geo strategic situation module should be an annex to an EXPEC. After the EXSPEC is issued, several other products for the other modules are developed based on the geo strategic module during the EP. Intelligence report is an example for this. An intelligent report must be consistent with the geo strategic module and more than one intelligent report are produced as a part of crises response planning, force activation and deployment, and execution information modules. The scenario development tool should fit in these requirements.

Table 1. Scenario modules.

Modules	Sub-modules
Geo-strategic situation	Map
	Historical background
	Political, military, economic, humanitarian, legal conditions
Theatre of operations	Map dataset
	Theatre data
	Country books
	Friendly and enemy order of battle
Strategic Initiation Module	Road to crises
	United Nations Security Council resolutions
	Strategic military assessment
	NAC initiating directive
	Strategic planning guidance
Crises response planning information	Intelligence summary
	Friendly forces
	Civil/military, environmental assessments
	Recce reports
	OPP tool data sets
Force activation and deployment information	ACTWARN/ACTREQ messages
	FORCEREP messages
	Allied force list
	Force balancing results
	SOFAs/MOUs/Tas
	Multinational deployment plan
	Intelligence summary
	Joint target list
	NCRS messages
	Rules of engagement authorization
Execution information	Road to war
	Intelligence summary
	Assessment reports
	Order of battle
	Situation reports
	Common operating pictures for C2 systems
	MEL/MIL database

Among the NATO tools in Table 2, joint exercise scenario tool (JEST) is being developed to generate scenario products. It is still under development, and has not been fully used in any exercise yet. The current version of JEST is designed mainly to prepare country books, exercise organization and ORBAT that can be fed directly into ORBAT editor, which is a tool used to develop the database for the forces in joint theatre level simulation (JTLS).

Table 2. NATO CAX support tools.

Tool	Description
Joint Exercise Scenario Tool (JEST)	Scenario preparation by also using on the shelf scenario products
Joint Exercise Management Module (JEMM)	MEL/MIL scripting and management
ORBAT Editor	Unit, target and terrain data collection for JTLS
Map Unit Builder (MUB)	Unit, target and terrain data collection for JTLS
Database Development System (DDS)	JTLS database management software
Terrain Modification Utility	JTLS terrain data management software
Joint Theater Level Simulation (JTLS)	A joint constructive simulation system for operational and higher levels
Joint Conflict and Tactical Simulation (JCATS)	A joint constructive simulation system for operational and lower levels
Joint Multi Resolution Model (JMRM)	An HLA federation where JTLS and JCATS are among the federates
Web Hosted Interface Program (WHIP)	WEB Enabled JTLS Interface
CAX DiStaff Environment (CADIE)	A software that provides operational picture from JTLS for the EXCON personnel
Joint Order Translation Module (JOTM)	A user friendly interface to enter orders into JTLS
Data Initialization Tools for OPP Systems	Data initialization scripts and interfaces for tools such as ADAMS and TOPFAS
JTLS ICC Mediation-ware (JIM)	Interface between JTLS and ICC
Formal Report Generator	The module which translates the updates coming from JTLS into text files that complies with the formal NATO message formats

Another important scenario product is the main events and incidents lists (MEL/MIL). In order to achieve the exercise objectives, events and incidents are designed and injections are developed according to them before the exercise. "*Events are major occurrences or a sequence of related incidents, which are actions or situations that provide greater clarity to an event. An injection is the way of bringing an incident to the attention of players*". They are listed in MEL/MIL that are usually not fixed, and should be modified during an exercise, i.e., dynamically scripted throughout the exercise.

In addition to this many injections are created automatically by the simulation system during a CAX. They should also be carefully monitored for two reasons:

- Exercise control (EXCON) staff needs to follow the management of the incidents and events from the beginning to the end. It may be sometimes possible that an incident created due to the developing situation by the simulation is missed at the beginning, and therefore not handled by TA and EXCON properly. This risk can be reduced by using a tool that can detect the incidents which rises from the developing situation in the simulation, and sends a warning message to the EXCON.
- Some of the incidents created automatically can hamper the exercise goals, and therefore may need to be removed in advance before they come into the attention of the TA.

As it is clear from the previous paragraphs, MEL/MIL management is a key requirement that does not only impact on the planning phase but also the execution phase of an EP. Even it is important also for the post exercise analysis and reporting phase carried out based on the actions taken by TA for the events and incidents. Therefore, a tool that can automate the MEL/MIL scripting, provides the interfaces between the MEL/MIL scripts and the simulation, and collects the lessons identified from the execution of the scripts, is important for CAX support. Joint exercise management module (JEMM) of NATO fulfils almost all of these functionalities. It is a developing software that has weaknesses on the detection of automatic injections by simulation and collecting lessons identified. It is widely used in NATO exercises and improves continuously according to the user feedback.

Another important part of scenario is friendly / enemy / situational forces and orders of battle which makes also the main part of the simulation database. During an EP the preparation of this database takes most of the time of CAX support personnel, and its accuracy has an impact on the results of simulation. A software that improves the efficiency of data collection, verification and validation has therefore the utmost importance. ORBAT editor of NATO is designed to collect the unit and target data and visualize them. We will further elaborate ORBAT editor in the next sub-section. The interaction of this kind of tools with the scenario preparation software can increase the efficiency of EP. JEST is planned to feed the data collected during the scenario preparation phase directly to the orbat editor.

2.2. Constructive simulation systems and ancillary tools

Military simulation systems are categorized into three broad classes shown in Table 3:

- *Live simulation* refers to a simulation that involves real people operating real systems, e.g. live exercises.
- *Virtual simulation* refers to a simulation that involves real people operating simulated systems, e.g. a flight or tank simulator.
- *Constructive simulation* refers to a simulation that involves simulated people operating in simulated systems, e.g. combat models.

Table 3. Military simulations.

Category	People	Systems
Live	Real	Real
Virtual	Real	Simulated
Constructive	simulated	Simulated

Although the interaction of these categories of simulation systems is possible by using the state of the art technology, and all of them, i.e., live, virtual and constructive simulations, may be used during the execution of a CAX, a military constructive simulation system constitutes the core of the CAX support. The definition of constructive simulation states that the people operating the simulated systems are also simulated. However, real people enter the commands during these simulations. Constructive simulations are designed to find out the possible outcomes of the courses of actions taken by the real people. They are constructed by many models often stochastic processes that calculate the results of interactions between the entities or units in a theatre.

Constructive simulation systems can be classified into two categories according to their resolution as summarized in Table 4:

- *High resolution simulations* are *entity level simulations* where singular military objects, e.g. a soldier, a tank, an aircraft, are the primary objects represented. They are designed for the lower military echelons such as platoon, company and battalion. The resolution of terrain data is higher sometimes up to the plans of individual buildings. However, the simulated terrain is often limited to 200 km × 200 km.
- Highly aggregated simulations are aggregate level simulations where collections of military assets, i.e., units, are the primary objects represented. They are designed for the higher military echelons such as corps level. They use lower resolution terrain data but they can simulate in very large areas as large as continents.

Table 4. Military constructive simulations.

Category	Level	Objects	Echelon	Terrain
High Resolution	Entity	Singular objects, e.g. tank, troop	Tactical, e.g., platoon, company	High resolution, 200km × 200km
Highly Aggregated	Aggregate	Units, e.g. battalion, company	Operational, e.g., corps	Low resolution, 4000km × 4000km

The gap between high resolution and highly aggregated simulation systems are tend to be closed. State of the art entity level simulations can be used up to operational levels, i.e., corps, and simulate in regions as large as 2500 km × 2500 km. On the other hand aggregate level simulations tend to be capable to simulate the entities such as a single troop and a tank. However, the nature of CPXs in operational and tactical levels enforces to assess the situation in aggregate and entity levels respectively, and the CPXs are manned according to this though it may sometimes be required to interact with the simulation in multiple levels. Therefore, the current trend is toward to have either a single system that can aggregate and de-aggregate the units and entities or a multi resolution federation of entity and aggregate level simulations.

The constructive simulation systems can also be categorized based on their functionalities as follows:

- Service models are the simulation systems developed for the needs of a single service, i.e., army, navy or air force.
- Joint models are either the simulation systems that fulfil the requirements of all services or federations made up of service models.
- Expert models are developed specifically to simulate certain functionalities in theatre such as logistics, intelligence, electronic warfare, homeland security and space operations. They can also join federations.

Various constructive simulation systems are used in NATO. Among these JTLS and joint conflict and tactical simulation (JCATS) are more important for JWC and Joint Force Training Centre (JFTC). JTLS is a highly aggregated joint constructive simulation systems used in CAXs supported by JWC. JCATS is a high resolution joint constructive simulation system that will be used in the exercises supported by JFTC.

Joint multi-resolution model (JMRM) federation depicted in Figure 3 is being developed in the US to integrate existing operational and tactical level simulations into a training federation. It is still being tested in the exercises in the US, and a part of this federation, i.e., mainly JTLS-JCATS federation, is also available for NATO usage. Therefore, we can expect multi-resolution distributed CAXs conducted by JWC and JFTC together.

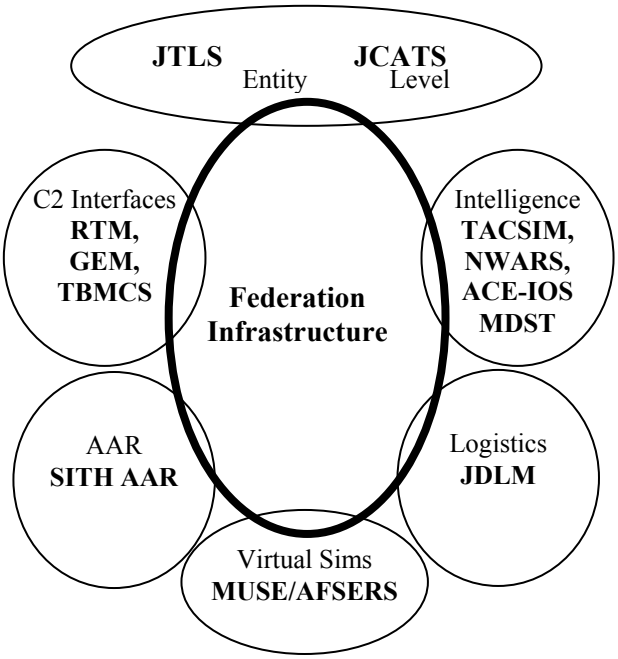

Figure 3. Joint Multi Resolution Model.

A user friendly interface is a very important component for constructive simulations. The user interface should also be easy to install and maintain as well as the data traffic between the simulation system and the interfaces should not be higher than the available network capacities. Web hosted interface program (WHIP) is the user interface for web enabled JTLS (WEJ). It is easier to install and maintain comparing to the GENIS-GIAC architecture used in previous versions of JTLS.

Ancillary systems reduce the overall cost of using constructive simulation systems during CAXs. These mainly include the tools that support the database preparation and review process for the simulation, and increase the efficiency of the procedures for the interaction between the EXCON and the simulation. Please note that the interaction between the TA and the simulation is different from the interaction between the EXCON and the simulation. That will be elaborated in the following subsection.

NATO has many ancillary systems that support JTLS. ORBAT Editor is one of them, and it provides a set of features that support the database preparation and review process for JTLS. These features include tools to review and update

- the unit data such as the name of the unit, the combat systems owned by the unit, associated targets, the other units that have the same characteristics,
- command structure,
- and support structure.

Map Unit Builder (MUB) supports CAX planners in the geographic setting of a CAX. This includes the modification of the terrain features and locating units in their start of exercise (STARTEX) positions. Please note that JTLS represents the terrain data by hexagons. MUB can modify the terrain characteristics (e.g., wood, desert, ocean, etc) and the altitude or the depth of the hexagons as well as the obstacles along the edges of the hexagons.

In addition to the unit and terrain data, a simulation database has even more details related to the lethality, communications, logistics and many other issues. Most of these data are transparent to TA and even EXCON personnel. Currently database development system (DDS) as well as standard query language (SQL) interfaces are used to enter and maintain these important data for JTLS. DDS and terrain modification utility (TMU) are the CAX database tools available in standard JTLS releases. DDS is used to create and modify all kinds of parametric, target and unit data. TMU is for terrain data maintenance.

CAX DiStaff Environment (CADIE) and joint order translation module (JOTM) are developed to provide an easy to use and powerful environment for planners and CAX support personnel to control a CAX. CADIE is mainly for EXCON to better monitor the situation in the simulation and to have the most up to date and clear perception about the latest operational picture. JOTM helps EXCON to develop plans and execute them in an efficient manner in the simulation.

Another important requirement is for semi-automated and automated forces software that can control the situational and enemy forces during CAXs. These tools can reduce the cost and the required manpower considerably. Moreover, they can increase the viability of using constructive simulation systems for offline experiments, i.e. experiments that are not carried out during a CAX. There is not such a tool available for JTLS or JCATS in NATO for the time being.

2.3. Mediation tools between the simulation and C4I/OPP systems

SYNEX tools must replicate C4I environments during CAXs. In other words, simulation systems and all the other related software must be transparent to the TA. They should carry out the exercise as they are in an operation and commanding their subordinates by using C4I systems normally available to them. They should also be able to receive the orders and to send the reports through these systems. This transparency can be achieved by the mediation tools between the simulation and C4I systems.

NATO has the mediation tools listed in Table 2. JTLS ICC Mediation-ware (JIM) is one of these tools. It provides the interface between JTLS and interim command and control (ICC) system which is an integrated C3I environment that provides information and decision support to NATO Combined Air Operations Centres (CAOC). JIM contains the following four modules:

- ICC initialize module initializes ICC with the data in the JTLS database.
- Air tasking order (ATO) compiler translates an ATO from the ICC format to JTLS orders.
- ICC update module updates ICC data based on the outputs of JTLS.
- ICC track formatter transforms JTLS track data into ICC format to show recognized air picture on ICC.

Table 5. NATO OPP tools.

Tool	Description
Tools for operational planning, force activation and simulation (TOPFAS)	It supports operational planning and force activation, and interfaces with ACROSS and ADAMS.
Allied deployment and movement system (ADAMS)	It supports the evaluation and planning of movement and transportation operations.
ACE resource optimization software system (ACROSS)	It calculates the munition requirements for the assigned forces.
Land-air-maritime battle determination algorithms (LAMBDA)	It is a spreadsheet application used for course of action evaluation and comparison.

Global aggregated model for military assessment (GAMMA)	It is a highly aggregated constructive simulation system designed to evaluate courses of actions.
Theatre level assessment model for aerospace related issues (TAMARI)	It is a theatre level air/land simulation system developed to analyze force compositions and identify requirements.

Another important mediation tool developed for JTLS is formal report generator that transfers the updates coming from JTLS into text files that complies with the formal NATO message formats. Then these text files can be e-mailed or passed to a military message distribution system where NATO C2 systems such as JOIIS, MCCIS and NORCCIS can read them and update their databases accordingly.

NATO has several OPP tools, and they also need mediation-ware for the simulation system used in CAXs. Important NATO OPP tools include but not limited to the ones depicted in Table 5. TAs are encouraged to use them during CAXs. However, this requires the initialization of them with the data from the simulation, and the ability to transform the plans developed by using these tools to the orders for the simulation should also be available. There are some preliminary designs and software that can partly achieve this.

For the time being, all of the NATO ancillary systems for the constructive simulations and C4I systems mediation-ware are developed for JTLS but not for JCATS. Their adaptation and modification for JCATS will be required when JMRM and JCATS are available for JWC and JFTC. The projects for this capability have already been planned.

2.4. Experimentation and Analysis Tools

A very important class of tools that completes CAX support is for processing the huge amount of data collected by the simulation system during CAXs. Without these tools it is almost not possible to evaluate the simulation results. These tools can analyze the performance data related to certain performance metrics according to a set of factoring parameters. They can even help to determine the performance metrics and factors based on the observable or controllable parameters in the simulation. Then they can present the results both in various tabular and graphical formats.

The current version of JTLS does not have such a post processor. JCATS has a post processor that needs further development for the NATO requirements. Apart from this, there are only preliminary versions of some modules that can be used for this purpose. We can conclude that this is an empty field for the NATO CAX support domain in especially JWC level.

3. JOINT CAX MANAGEMENT SYSTEM

In the previous section, we elaborate the requirements and capabilities of NATO CAX support tools available for JWC and JFTC. In this section we provide our preliminary thoughts about the design of a joint CAX management system (JCMS) that integrates all classes of CAX support tools into a single web based efficient system of modules. JCMS has three main components:

- JCMS database
- JCMS server
- Web based JCMS interface

JCMS server is a collection of modules that can be invoked by users using a web browser either through local area or wide area access. Moreover, it is also possible to replicate the database and the server for batch mode remote site installation and merge the data collected at the remote site into the main database as required.

Users, their access rights, and the procedures that update the database are arranged such that it matches with the current EP. For example, only OCE officer of primary responsibility (OPR) can submit an exercise planning guidance only after the related EXSPEC is submitted to the system.

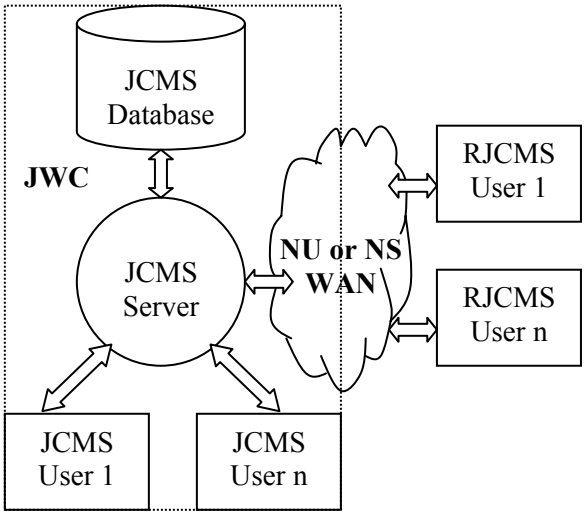

Figure 4. The general architecture of JCMS.

3.1. JCMS Database

JCMS has a relational database that manages four categories of data shown in Figure 5.

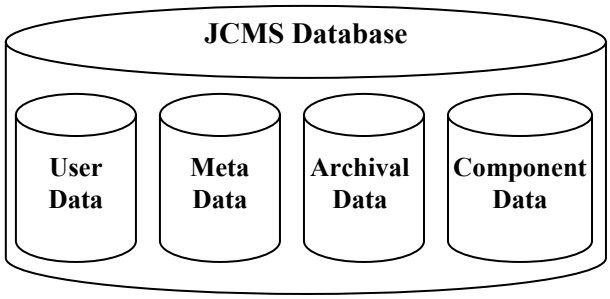

Figure 5. JCMS database.

User data defines the users, their contact details as well as their access rights.

Meta-data is the data that defines the characteristics of the data available in JCMS database. For example, the name, type and size of a scenario available in JCMS database can be stored among the meta-data to be able to find out a previous scenario that fulfils the requirements for a new scenario the best.

Archival data are the data from the previous exercises. These archives contain all the products, databases, and the data collected during an exercise, including:

- OSE exercise guidance
- EXSPEC
- OCE exercise planning guidance
- Scenario products including MEL/MIL
- Exercise plan (EXPLAN)
- Operational plans (OPLANS)
- JTLS and JCATS databases
- Checkpoint data for JTLS and JCATS
- Lessons identified
- Final exercise reports and lessons learned

Component data are the components needed for the EP products and constructive simulation system databases. These data are in the most generic form. This does not mean that they cannot be based real data. They can be real data but they do not contain fields like date and unit name. They are atomic which means that they cannot be decomposed into smaller components. Component data include the following:

- Terrain data have both real and fictitious terrain. Raster maps, vector data in various details (e.g., as detailed as building plans), elevation and depth data in various resolution shall be available in this database.
- Components related to country books include political, military, economic, cultural, humanitarian, legal data as well as data about important political figures. A new country book can be created by synthesizing these components.
- Events and incidents can be categorized such that those for the road to crises, combat, peace support, crises response operations related.
- Components related to other scenario products such as United Nation Security Council resolutions, North Atlantic Council Directives, assessment reports are also among the component data.
- Prototypes for units, targets, combat systems, supply categories should be available for both real and fictitious scenarios. These data can include many details as much as three dimensional models and pictures for the combat systems and targets.
- Templates with default data for the EP products such as EXPEC can be also served in JCMS database.

3.2. JCMS Server

JCMS server provides the interfaces and procedures to manage the JCMS database such that a CAX process from the EXSPEC preparation until the AAR is effectively supported. It encapsulates the modules shown in Figure 6 into a software system. The interrelations of the modules are shown in Figure 6. Please note that each module has also outputs and interactions with JCMS database. Please also note that JCMS is only a draft design, and there is no prototype available yet.

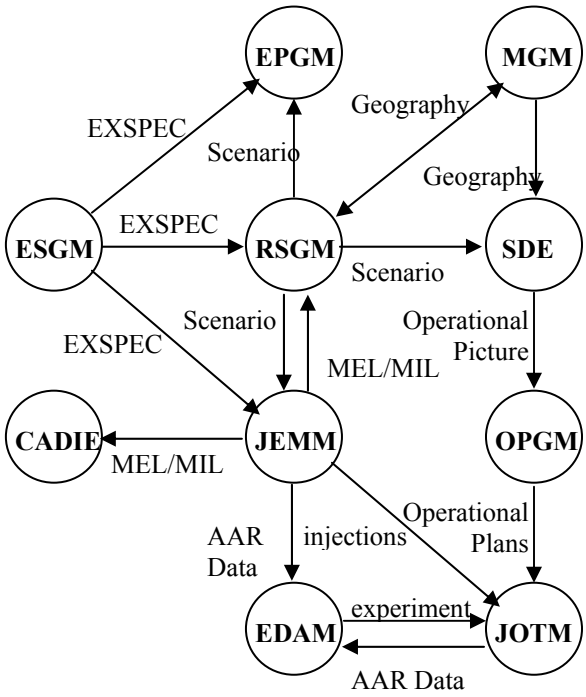

Figure 6. JCMS modules and their interrelations.

Map generation module (MGM) merges country and terrain data and generates raster maps at various scales ready to be printed. It also provides elevation data and terrain features at various layers in the detail and format required by the constructive simulation system.

Rapid scenario generation module (RSGM) rapidly generates all scenario modules by using the component data according to the user specified parameters. It also provides the interfaces to access the meta-data about scenario modules, to select the most appropriate scenario from the archives and to scrutinize the selected scenario according to the current requirements. This module generates the preliminary inputs for the simulation database editor.

EXSPEC generation module (ESGM) is for the automation of the EXSPEC preparation process. It provides a structured procedure to generate an EXSPEC and also minimizes the amount of the work power for EXSPEC production. It can access meta-data and archival data to select and scrutinize the EXSPECs in JCMS database.

EXPLAN generation module (EPGM) is similar to ESGM. It provides the procedures for EXPLAN generation.

Joint exercise management module (JEMM) is the module used to prepare MEL/MIL and steer the execution phase of an exercise towards the goals of the exercise. It also collects the data for AAR. For each incident the response and factoring parameters are selected, e.g., aircraft loses, time and the number of CAP missions, and JEMM collects and sends these data to the analysis module. Moreover, JEMM provides the interfaces for EXCON staff to enter the observations on the reactions of TA for each incident. These records are then analyzed for the AAR.

Simulation database editor (SDE) is for the generation of the simulation database. It receives some initial data from RSGM, and provides efficient and user friendly interfaces to create the simulation database.

OPLAN generation module (OPGM) is similar to ESGM and EPGM. It also provides the interfaces to initialize the NATO OPP tools with the current operational picture in the simulation system as well as to pass the generated plans to joint order translation module.

Experimentation, Data Collection and Analysis Module (EDAM) is the post processor of the system. It helps the users to design the experiments during the simulation. The parameters that can be observed and modified during the execution of a simulation are introduced by EDAM. The user can design an experiment based on this parameters, then EDAM collects, analyzes and presents the results in various formats. It also receives the data from JEMM for the incident specific observations, analyzes and presents them.

CAX distaff environment (CADIE) and joint order translation module (JOTM) are used the same as the current NATO tools CADIE and JOTM.

3.3. JCMS User Interface

JCMS user is a member of EXCON. TA will continue to use C4I systems. We hope battlefield management language (BML) will be available to replace the mediation-ware such as formal report generator.

JCMS user interface can be web based or a client application compiled for specific platforms. They will normally be used on line either in JWC or in remote sites. Moreover, the replication of JCMS database and server for remote offline usage will also possible. This option is for the offline workshops, conferences and meetings in the remote sites. JCMS will be able to merge this kind of offline updates into the JCMS database.

3.4. Standards and Formats

For the time being our design of JCMS is not in data formats detail. However, the industrial standards and formats such as DTED, U3D, SCORM, BML and pdf will be considered in the design of JCMS database and server modules. The NATO standards will be carefully followed in this design.

4. CONCLUSION

CAX support tools can be categorized into four classes: exercise planning and management tools; constructive simulation systems and ancillary tools; interfaces between C2 systems and simulations; experimentation and analysis tools. NATO already has various systems that fall in these categories. However, they are not enough to fulfil all the requirements. A more structured and integrated system that supports a CAX process from the very beginning until the AAR is needed. Our JCMS design provides the preliminary ideas for the requirements of this system.