An Integrated Solution to C4I and Simulation Initialization

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ABSTRACT

Most medium to large-scale training exercises today involve digital Command, Control, Communications, Computers, and Intelligence (C4I) systems integrated with live, constructive, and virtual simulations. The U.S. Army has traditionally expended tremendous resources to ensure that the individual C4I systems within the Army Battle Command System (ABCS) start an exercise with an accurate, complete, and consistent set of initialization data. When digital C4I systems are integrated with either a simulation or federation of simulations, the complexity is significantly increased. Federations of simulations and their associated databases must be initialized and synchronized with the C4I systems that they interface with at the start of an exercise (StartEx). In addition to training applications, simulations and C4I systems are now being integrated for system testing, mission planning, course of action (COA) analysis, and mission rehearsal.

To meet these challenges, the Army's Program Executive Office, Command, Control, Communications, Tactical (PEO C3T) with members from the Defense Modeling and Simulation Office (DMSO) and the Army's Simultion-to-C4I Interoperability (SIMCI) Consortium, developed the Army C4I and Simulation Initialization System (ACSIS). The purpose of ACSIS is to establish an integrated database of authoritative data from which to build initialization data load products for both C4I systems and simulations based on a particular mission-specific Unit Task Organization (UTO).

Although, this paper will use ACSIS as a specific example of Army C4I and simulation StartEx integration, our intent is to provide the reader with experiences that are applicable to C4I and simulation integration for any Service or for Joint application.

ABOUT THE AUTHORS

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INTRODUCTION TO ARMY C4I SYSTEMS AND SIMULATIONS

One of the key aspects of U.S. Army Transformation is the fielding of the Army Battle Command System (ABCS). ABCS is a system of systems that includes a number of Battlefield Automated Systems (BAS) such as the Maneuver Control System (MCS-Maneuver), Advanced Field Artillery Tactical Data System (AFATDS-Fire Support), All Source Analysis System (ASAS-Intelligence), and other systems in each Battlefield Functional Area (BFA) operating on the Upper Tactical Internet (UTI) network. The Force XXI Battle Command Brigade and Below (FBCB2) system is a battle command information system mounted on individual platforms operating on the Lower Tactical Internet (LTI) network and provides situational awareness of both friendly and enemy units. FBCB2 systems can communicate digitally with other FBCB2 systems and with BAS components of ABCS in Command Posts (CPs) and Tactical Operations Centers (TOCs) (see Figure 1).

Data interoperability is a key aspect of system interoperability. When placed into operation, digital Command, Control, Communications, Computers, and Intelligence (C4I) systems and their associated databases must be initialized with a complete, accurate,

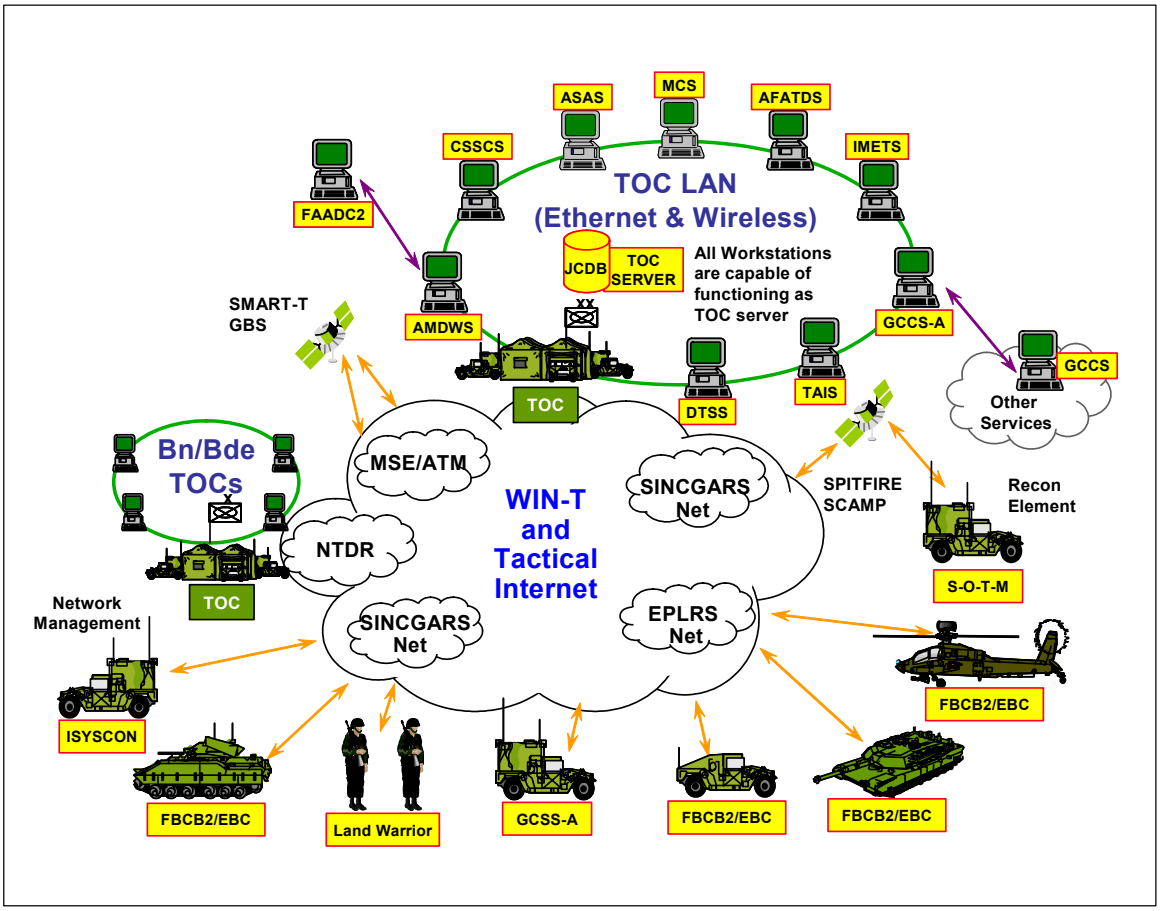

Figure 1. ABCS Architecture

and synchronized set of data. System operators and information integrators build on this data set based on operational or exercise-specific plans and orders from their commanders and staffs. One system of systems aspect of ABCS is its reliance on each of its component systems to provide their particular contributions to the Joint Common Database (JCDB) to produce a Common Operational Picture (COP) of the battlefield.

Most medium to large-scale training exercises today involve digital C4I systems integrated with live, constructive, and virtual simulations. The primary focus of data integration is information about units, their organization, associated personnel and equipment, and their communications architectures.

Examples of simulations that are integrated with Army C4I systems are constructive simulations such as the Digital Battlestaff Sustainment Trainer (DBST) federation and the Corps Battle Simulation (CBS)/Run Time Manager (RTM), live training environments such as the Digital Multi-Purpose Range Complex (DMPRC) and the Fixed Tactical Internet (FTI), and virtual simulations such as the Close Combat Tactical Trainer (CCTT).

LEGACY METHOD OF DATA PREPARATION

The U.S. Army has traditionally expended tremendous resources to ensure that the individual BASs within the ABCS start an operation or exercise with an accurate, complete, and consistent set of initialization data. When these digital C4I systems are integrated with either a simulation or a federation of simulations, the complexity is significantly increased. Federations of simulations and their associated databases must be initialized and synchronized with the C4I systems that they interface with at the start of an exercise (StartEx). In addition to training purposes, simulations and C4I systems are now being integrated for system testing, tactical mission planning, COA analysis, and mission rehearsal.

In most cases, preparation for a military training exercise or testing event begins with an exercise C2 "white cell" developing a scenario and issuing higher headquarters' operations orders (OPORDs), annexes, overlays, matrices, enemy situation, and other exercise-specific StartEx instructions. Currently, C4I databases are built and distributed by a number of contractor organizations to initialize the C4I systems for an exercise. Training unit C4I operators and information integrators will then manipulate the data, modify the data sets, and distribute data products based on the plans, orders, and guidance from their commanders and staffs. Sometime during this process, the exercise C2 white cell and the training units will provide the necessary StartEx data to the simulations planners and technicians. Normally this data is provided in hardcopy or in some digital format such as MS Word, Excel, or PowerPoint. With this data, the technicians for each simulation and C4I interface of a federation must manually build or modify an existing data file to prepare the simulation/interface for the start of the exercise (StartEx).

All the different simulations and C4I interfaces use different scenario generation tools and GUIs to build proprietary formatted files or databases containing the exercise-specific StartEx data. Some simulations have begun to use translation or parsing programs to import standard tactical data products provided in some specific format (e.g., Air Tasking Order in MS Word format).

As the exercise planning and preparation continues, changes in the exercise scenario are made by the exercise C2 white cell and the training units. Corresponding changes must be made in the C4I data sets, and these changes are provided to the technicians to make the necessary changes in the simulations and their ABCS interfaces. Digital rehearsals are scheduled to identify and fix data inconsistencies and network configuration and addressing problems. This iterative process to identify and fix data inconsistencies and errors continues throughout the exercise preparation and V&V period to insure that complete and accurate data is synchronized across all the C4I systems, simulations, and their interfaces before the start of the exercise. Needless to say, this is a very manpower and time intensive, error prone, and costly process. For a large scale (e.g., brigade-level or higher) training exercise, C4I data preparation can take many months and the associated simulation data preparation can add several more weeks.

IMPROVING THE INITIALIZATION PROCESS

To meet these challenges, the Army's Program Executive Office, Command, Control, Communications, Tactical (PEO C3T) with members from the Defense Modeling and Simulation Office (DMSO) and the Army's Simultion-to-C4I Interoperability (SIMCI) Consortium, developed the Army C4I and Simulation Initialization System (ACSIS). The purpose of ACSIS is to establish a integrated database of authoritative data from which to build initialization data load products for both C4I and simulations based on a particular mission-specific Unit Task Organization (UTO).

The PEO C3T originally started the Initialization Capability (IC) project under the Product Manager Communications Management Systems (PdM CMS). The intent of the Objective IC is to provide the Warfighter (command and staff) with the ability to generate and update mission-specific initial configurations for C4I systems and devices. The intent is to also disseminate these initial configurations and data products. The scope of IC was limited to the C4I network structures and was focused on the to-be-fielded ABCS version 7.0 (MITRE Corporation for PdM CMS, 31 March 2002). Also, the original IC program did not address simulation initialization.

In February 2003, the Director of the Central Technical Support Facility (CTSF), PEO C3T, was appointed the IC "Trail Boss" by PEO with the directive to achieve Initial Operational Capability (IOC) by 30 September 2003 (BG Michael R. Mazzucchi, 14 February 2003). The resulting CTSF IC Strategy Statement changed the IC focus to the current ABCS version 6.x and includes simulation initialization as a requirement. Phase I (IOC) was defined as an operational ACSIS database and ACSIS Tool Suite to be used by the CTSF data managers to generate designated C4I and simulations initialization data load products.

ACSIS PHASE I

The ACSIS database includes harmonized data for all Army units from the U.S. Army Force Management Support Agency (USAFMSA), Global Status of Resources and Training System (GSORTS), Joint Master Unit List (JMUL), and the Force XXI Integration Office (FIO) System Architecture (SA) databases. The ACSIS Tool Suite was developed to build a mission-specific, or exercise-specific UTO from the Modified Table of Organization and Equipment (MTOE) and the FIO SA data. In addition to the unit order of battle data, the ACSIS database also includes the electronic order of battle data. The electronic order of battle starts with the FIO SA data that includes all organizations, cells, and platforms with computers, radios, and electronic equipment that make up a number of voice and digital communications networks. From this FIO SA data, the ACSIS Tool Suite adds additional network configuration and addressing data to the ACSIS database to establish each system network for both the Upper and Lower Tactical Internet. From this complete, accurate, and synchronized set of initialization data within the ACSIS database, the ACSIS Tool Suite will generate initialization data loads for the Joint Common Database (JCDB), the Force XXI Battle Command Brigade and Below (FBCB2), the Tactical Internet Management System (TIMS), and the Command and Control Registry (C2R) and the Lightweight Directory Access Protocol Data Interchange Format (LDIF).

The ACSIS Tool Suite generates partial initialization or StartEx files for simulations and their C4I interfaces based on the same UTO and the same electronic order of battle data used to generate the C4I initialization data loads. The ACSIS Tool Suite selects the appropriate data from the ACSIS database and generates StartEx files, in their native formats, for the Run Time Manager (RTM) of the Corps Battle Simulation (CBS), and simulations of the DBST federation including Janus, and FireSim XXI. The ACSIS Tool Suite is also being developed to generate StartEx files for other simulations and C4I interfaces of the DBST federation such as the Extended Air Defense Simulation (EADSIM), the Enhanced Tactical Simulation Interface Unit (ETSIU), and the Enhanced Protocol Interface Unit (EPIU). The ACSIS team has also begun development of initialization files for the Joint Conflict and Tactical Simulation (JCATS), the One Semi Automated Forces (OneSAF), and the Warfighter's Simulation (WARSIM) in subsequent phases of ACSIS development.

SIMULATION INITIALIZATION REQUIREMENTS

Most simulations today include a master database of persistent data that includes entity characteristics and performance data, interaction algorithms, synthetic natural environment, etc. These databases are not necessarily relational. Most simulations use flat files or binary files of semi and non-persistent data to define exercise-specific organizations (e.g., units, aggregates) and entities (e.g., vehicles, weapon systems, dismounted soldiers) and other scenario-specific data. Simulation StartEx data includes many types of data. ACSIS addresses those types noted in Figure 2, but some types of data (e.g., terrain) have been determined to be outside the scope of ACSIS.

Legacy simulations use "black box" interfaces (e.g., EPIU, ETSIU) to translate and exchange standard ABCS message formats (e.g., USMTF, VMF) between the simulations and the live C4I systems. The simulations and the C4I interfaces must be initialized with the C4I digital network structures, nodes, and addressing information in order for the simulations and the live C4I systems to properly exchange data and information during "run-time".

Simulation StartEx Data

- ✓ Unit Task Organization (UTO)
- ✓ C2 & Support Relationships
- ✓ Communications structures, nodes, networks
- ✓ URNs, IP addresses, frequencies, aliases
- ✓ Enemy information
- ✓ Entity Identification - weapon systems, vehicles, personnel, sensors, equipment
- ✓ Entity position/location and orientation
- ➢ OPORDs, Annexes, overlays, matrixes
- ➢ Unit formations
- ➢ Man-made obstacles and fighting positions
- ➢ Entity/Unit logistical status
- • Unit specific TTPs, Tactical SOPs
- • StartEx date/time
- • Terrain database
- • Weather conditions

✓ = ACSIS Phase I
➢ = ACSIS Future Phases
• = Outside of ACSIS scope

Figure 2. Simulation StartEx Data

A simulation such as Janus may include a surrogate FBCB2 system next to a Janus workstation. The Janus workstation "puckster", who is controlling a number of platforms in the simulation, is able to transmit the location of the platforms from the FBCB2 system and exchange tactical messages with other FBCB2 systems and the live ABCS systems in the higher headquarter TOC, which may be fully manned and operational outside the simulation center. The FBCB2 network is integrated with the Janus simulation so that the Janus workstation puckster is able to see friendly units and platforms on both the FBCB2 and the Janus workstation displays that would normally be beyond the simulated field of view without FBCB2. The Janus puckster is also able to see simulated enemy units and platforms on the FBCB2 display that are reported by other friendly units and sensors across the FBCB2 and ABCS networks.

Even with automation, changes in an exercise scenario will continue to occur right up to the start of an exercise and require corresponding changes in the data across C4I systems and simulations, but an integrated source of initialization data and standard automated tools to propagate and distribute these changes across a network will significantly reduce exercise preparation time and cost and reduce data inconsistencies and errors.

AUTHORITATIVE DATA SOURCES

The ACSIS includes an integrated database from which to generate designated C4I and simulation initialization data load products. There are a number of authoritative data sources from which to populate the ACSIS database with the initialization data required by C4I systems and simulations. A particular data element from one authoritative source may conflict with another authoritative source. The intent is to de-conflict or harmonize the authoritative data in the ACSIS database so that it can be used to generate each of the designated C4I and simulation initialization data products. Authoritative data is not always 100 percent correct. A Configuration Management (CM) process must include feedback loops to authoritative data sources to more accurately reflect what Army units have or need "on-the-ground". The primary data sources for ACSIS are described in the following paragraphs.

USAFMSA and GSORTS Data

USAFMSA provides support, analysis, and discipline for the Army's personnel, materiel, resource, and force managers' plans and decisions. USAFMSA also documents manpower and equipment requirements and authorizations for the Army. GSORTS is a joint forces management tool reflecting the readiness level of selected units in terms of training, equipment, and personnel against the level required to undertake assigned missions.

DMSO had previously developed a tool, called the Unit of Battle Data Access Tool (UOB-DAT), to extract MTOE data from USAFMSA and GSORTS databases. This tool was designed to extract organization data (e.g., unit identifiers, names, and unit types), Unit Task Organization data (e.g., unit command and support relationships), and assigned equipment, and personnel. This UTO data and assigned equipment and personnel range from the division level down to the squad and team level. The ACSIS requires an automated process to periodically update the ACSIS database when this authoritative MTOE data is updated by USAFMSA and GSORTS. DMSO has modified the UOB-DAT to include a process called the ACSIS Authoritative Data Source Update Process (AADS-UP). The AADS-UP process compares existing ACSIS data with updated USAFMSA data, identifying data fields as the same, added, or moved, and then generates the SQL needed to update the ACSIS database.

Force XXI Integration Office (FIO) System Architecture (SA) Data

U.S. Army TRADOC manages Command, Control, Communications and Computers (C4) equipment distribution requirements through the C4 Requirements Definition Program (C4RDP). Operational Facility (OPFAC) rules and C4 equipment requirements are proliferated throughout the Army in the form of the OPFAC Rule Book. The PEO C3T, Force XXI Integration Office (FIO) System Architecture (SA) defines the communications components and network structures of standard U.S. Army units based on the OPFAC rules. The ACSIS database includes the digital communication network data for U.S. Army units in accordance with the OPFAC Rules and FIO SA data.

The FIO SA data for a particular digital unit defines the normal or "garrison" UTO of the unit, the platforms (e.g., vehicles, TOCs, aircraft, individual dismounted soldiers) that host a number of C4I systems (e.g., FBCB2, AFATDS, MCS). The FIO SA also includes OPFAC "platform roles" of the person or cell associated with each C4I system (e.g., BN S2 OFF, SCOUT SQD LDR, BDE INTEL CELL, etc.). In addition to the C4I systems, the FIO SA data also includes the communication devices (e.g., EPLRS, SINCGARS, NTDR, etc.) and the digital equipment (routers, switches, mux, etc.) for all the voice and digital networks, and the linkages between all these objects.

The FIO SA data does not include all the required network configuration and addressing data. From the FIO SA and MTOE source data, the ACSIS Tool Suite can build a mission-specific UTO, modify the FIO SA network structure as a result of the new UTO, and generate additional data based on C4I system network configuration and addressing rules to further define networks in the Upper and Lower TI. For example, TOC subnets and IP addresses can be assigned, Enhanced Position Location Reporting System (EPLRS) Radio System IDs (RS_IDs), needlines, and Logical Channel Numbers (LCNs) can be configured and assigned, and platform roles can be assigned to designated FBCB2 individual, broadcast, and multicast group Unit Reference Numbers (URNs). Platform roles for training purposes must also be added to the networks such as Digital Army USMTF VMF Stimulators (DAUVS), observer controllers, and digital data collection devices.

The concept of an integrated authoritative database also provides the opportunity to assign unique keys such as the Organization IDs (ORG_IDs) to all Army units at each echelon level down to the individual soldier billet level. Each platform role is assigned a unique Unit Reference Number (URN) and IP address. Provisions will be made to include ACSIS assigned Army ORG_IDs and URNs in the Joint System Initialization Database (JSID).

Simulations that interface with live C4I systems require that the digital communications nodes, components, and network configuration and addressing data are defined in the simulation StartEx files and in the C4I interfaces. Some simulations can simulate a large or small portion of the digital nodes and networks and exchange data with the live C4I nodes and networks of the training units. Other simulations use role player workstations to exchange data with the live C4I nodes and networks of the training units.

ACSIS DATABASE DESIGN

The initial focus of the ACSIS database design was to produce a schema to support the import of data from authoritative sources. The ACSIS database was designed with relational modeling techniques. The intent was to design an integrated database that would enforce data integrity of primary keys and other constraints that enforce UTO and digital network structure rules and prevent duplicate primary keys such as unit identifiers and network addresses.

The design of the ACSIS database was an exercise in tradeoffs between the way data sources represent the needed information and the way the C4I systems and simulations that consume ACSIS information represent the same information. The primary source foci were the MTOE data from USAFMSA and the FIO SA data. The C4I system foci were the initialization data requirements of the JCDB, C2R, FBCB2, and TIMS databases. Integrated with these two were the initialization data requirements from the target simulations and their C4I interfaces.

A particular data element's data type, maximum number of characters, domain value, allowable null values, and/or naming convention may be different across C4I systems databases and/or simulation StartEx data files. In addition, two or more of these target databases or data files to be initialized may use different schemas, data elements, data types, and primary keys to define the same information, such as the unit order of battle or UTO. Also, different C4I databases include different values in reference or "look-up" tables. The intent is to standardize data element data type, maximum number of characters, domain value, allowable null values, naming convention, and schema to the extent possible. The

ACSIS Tool Suite must be able to translate the ACSIS data to the particular syntax and naming conventions as required by each C4I and simulation initialization data load product. The only feasible approach is to include cross-reference look-up tables to provide the translations among C4I system and simulation databases.

One example of a database design decision to accommodate both C4I and simulation concerns is the inclusion of a notional organization table. The ACSIS database includes an ORGANIZATION table for actual friendly forces and a NOTIONAL ORGANIZATION table for notional friendly forces and enemy forces. Notional friendly forces do not actually exist in the Army but are used in training exercises; for example the notional 52nd Mechanized Division Headquarters is used at the National Training Center (NTC) to play the role of the division headquarters element for the actual brigade in the training area. Although the data elements used to describe actual, notional, and enemy forces are virtually the same (and general database design principles would say to store them all in one common table), these are kept in separate tables in ACSIS. The C4I community is sensitive to the mixing of real and notional units, thus outweighing general principles of database design, which might be applied for simulation systems.

ACSIS TOOL DESIGN

In addition to a database, ACSIS includes a tool suite that allows users to view, modify, and transform data. The ACSIS Tool Suite is used to create or build a Unit Task Organization (UTO), select data from the ACSIS database, add additional network configuration and addressing data, and then produce the C4I and simulation initialization data loads and files in the native file format of the C4I systems or simulations for the created UTO (see Figure 3).

Currently, the ACSIS Tool Suite includes a Java-based core application that allows the user to view the data in each ACSIS table and to select columns from any table to be displayed. This application also allows the user to create and view mission-specific or exercise-specific Unit Task Organizations (UTOs) in the ACSIS database. The ACSIS database includes a baseline UTO (version 1.0) that includes the "garrison" UTO of all units in the U.S. Army. The intent of ACSIS is to include all units and their associated MTOE equipment and personnel down to the squad/team and billet level. From the baseline UTO 1.0, in preparation for a specific operation, testing event, or training exercise, the ACSIS Tool Suite user can create or modify a UTO, under a new UTO index and version, with any combination of units and their associated equipment and personnel. Then the ACSIS Tool Suite will

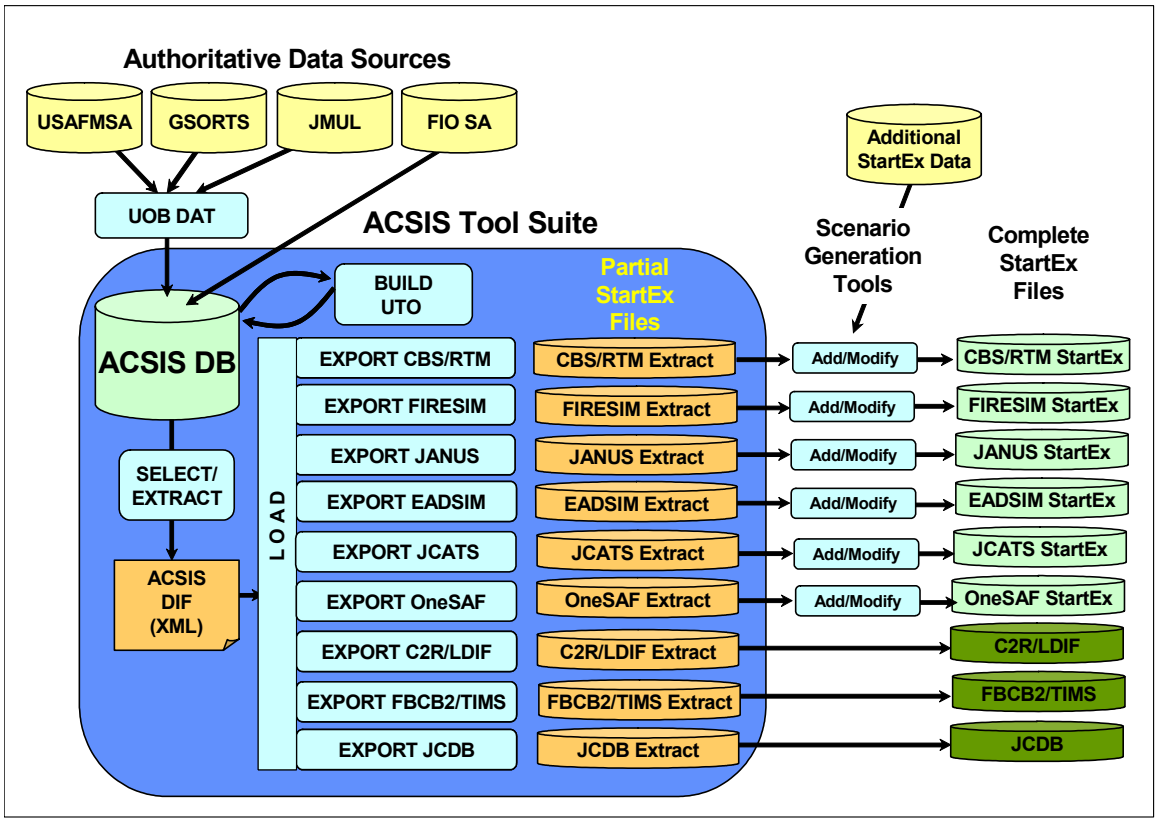

Figure 3. ACSIS Architecture

generate the appropriate network configurations and addressing data for the new UTO based on the FIO System Architecture (SA) data for each organization and the Upper and Lower TI network configuration and addressing rules for each specific network. Currently the ACSIS Tool Suite includes the Java-based core application integrated with the PEO C3T C2R Planner tool. In Phase II of the ACSIS development cycle, the FBCB2 Planner and the TOC Planner tools, currently under development, will also be integrated with the ACSIS Tool Suite.

Use of XML for Data Interchange

The ACSIS Tool Suite selects and extracts data from the appropriate ACSIS database table for a particular simulation or C4I interface and produces standard Extensible Markup Language (XML) files. These XML files include the StartEx data required by the simulation or C4I system. For C4I systems and simulations directly supported by ACSIS, the tool translates the XML files to produce delimited text files that can be loaded into the C4I or simulation database. For simulations not currently supported by ACSIS (in terms of producing simulation-specific formatted files), simulation technicians may choose to use the XML files as a universal data interchange format (DIF). They then can write their own tools to translate the ACSIS XML output to the flat files or binary files of exercise-specific StartEx data that can be imported directly into the simulation application. This approach has already proven valuable by allowing simulations currently under design and development (specifically Objective OneSAF and WARSIM) to obtain ACSIS data via the XML interface. Simulations that have a direct (native file format) interface with ACSIS are described in the following paragraphs.

Run Time Manager (RTM) Initialization Data Load

The Corps Battle Simulation (CBS) uses a C4I interface called Run Time Manager (RTM). RTM uses an Oracle database that includes tables that define the exercise UTO and the specific communications nodes, networks, and addressing data. For a number of CBS exercises, the ACSIS Tool has generated and provided pipe-delimited text files to RTM in a matter of minutes. Using traditional processes, generation of these files would take the RTM technicians days or weeks to build.

Digital Battle Staff Sustainment Trainer (DBST) Simulations StartEx files

The ACSIS Tool Suite also uses the XML files to generate simulation StartEx files in the native formats that the simulation technician can upload directly into their normal scenario generation tools or GUIs to modify elements or to add StartEx data that is not currently provided by ACSIS. For example, the Digital Battle Staff Sustainment Trainer (DBST) is a federation of simulations including Janus, FireSim XXI, and EADSIM that interface with ABCS through the ETSIU and the EPIU. The ACSIS Tool recently produced StartEx initialization binary files for an exercise-specific UTO in the Janus simulation. Janus is a stochastic entity-based, platoon-to-brigade level, ground and air-ground combat constructive simulation system (TRADOC Analysis Center-WSMR, July 2000).

In Janus, binary files define the UTO hierarchy of all the aggregates (organizations or units) and the entities (vehicles, platforms, weapon systems, dismounted soldiers) assigned to each aggregate for both the friendly (BLUE) and the enemy (RED) forces to be simulated in Janus. The Janus technician will normally use a reference document provided by the exercise C2 white cell or the training unit to manually build the UTO, or modify an existing UTO, for a particular exercise using the FORCE definition GUI on a Janus workstation. The ACSIS Tool can build, in a matter of minutes, the UTO in the ACSIS database from authoritative MTOE and FIO SA data, generate the XML files, and produce the binary files that can be directly imported into the Janus FORCE definition GUI for any required modifications or additions. The ACSIS Tool Suite user can also designate the initial starting locations of the aggregate units on the simulation map. Also, if the Janus players are using FBCB2 to communicate with other Janus players, live FBCB2 systems, and other live ABCS systems in the training units' Tactical Operations Centers (TOCs), the ACSIS Tool can provide the FBCB2 network structure and URN addressing data required by the simulation. This process can save the Janus technician days or weeks of time to define and deploy the UTO hierarchy of aggregate units and entities based on an authoritative source of both BLUE and RED force structures.

The ACSIS Tool Suite development team is currently working on producing StartEx files for the FireSim XXI simulation. FireSim XXI is a simulation system for artillery forces. It simulates the target acquisition, command, control, and communications, weapon/target allocation, logistics, firing platforms, and munitions to a high level of detail. FireSim XXI communicates with all Field Artillery Tactical Command and Control systems and to ABCS through the Advanced Field Artillery Tactical Data System (AFATDS). FireSim accepts and issues fire missions to/from live and simulated units and provides battle damage reports

resulting from both simulated and live fire missions. Fires may be scripted or generated dynamically by live tactical players or the FireSim operator. FireSim XXI operates automatically by exchanging data with live C4I systems in the training unit's Tactical Operations Centers (TOCs), Fire Support Elements (FSEs), Fire Direction Centers (FDCs), and firing units (US Army Depth and Simultaneous Attack Battle Lab, 1 January 2001).

To prepare the simulation for a particular exercise, the FireSim operator must manually build, or modify a number of existing ASCII text files called "mix files". These mix files define the exercise-specific fire support architecture of FSEs, FDCs, firing units (guns and launchers), sensors (artillery locating radars and observers), and ammunition resuppliers to be simulated. The mix files also define the networks of digital Field Artillery Tactical Command and Control systems and network addressing data between these different simulated elements and how they interact and communicate through the EPIU with live Fire Support C2 systems in the training units' TOCs. The production of a FireSim mix file, or the modification of an existing mix file, containing sequential command lines in an ASCII text editor is a very time consuming, complex, and error prone process. The mix files use special directive command words and strict command line syntax to define the fire support architecture, FSEs, FDCs, firing units, sensors, digital networks, ammunition resuppliers, and the initial positions of each. A mix file must be built for both the BLUE and the RED forces. The tactical AFATDS system database must include this same data to define the BLUE force fire support architecture of live and simulated elements and their digital networks for a particular exercise. As a integrated source of complete, accurate, and consistent data, the ACSIS database can be used to initialize and synchronize both the live AFATDS systems and the FireSim XXI simulation and its EPIU interface. The ACSIS Tool will, in a matter of minutes, build a graphical display of the of the fire support architecture of live and simulated elements and their digital networks for a particular exercise and generate both the BLUE and RED mix files that can be directly imported into the FireSim XXI application for any required modifications or additions.

The ACSIS Tool Suite development team is also currently working on producing StartEx files for the EADSIM simulation. EADSIM is an analytic model of air and missile warfare. It was one of the first models to allow each platform (such as a fighter aircraft) to be individually modeled, as well as the interaction among the platforms. It models the C2 decision processes and the communications among the platforms on a message-by-message basis. Intelligence gathering is explicitly modeled and the intelligence information is used in both offensive and defensive operations (US Army Space and Missile Command, November 2000).

In additional to building exercise-specific UTOs, the ACSIS Tool Suite will allow users to modify select data fields in the ACSIS database to define the StartEx conditions at the start of the exercise. For example, the initial starting locations for units, individual platforms, weapon systems, the initial unit MOPP level, and ADA warning status, can be designated.

The ACSIS Tool Suite also includes capabilities to identify and correct ACSIS data inconsistencies, errors, and duplications. The ACSIS Tool Suite will check data fields for syntax errors and allow the user to correct errors based on established rules and naming conventions displayed to the user with an error message. The ACSIS Tool Suite will also identify duplicate data within a single data field and allow the user to resolve such duplications. The ACSIS Tool Suite will perform data quality control to insure data integrity across the entire ACSIS database.

CONCLUSIONS

The primary value of this PEO C3T, DMSO, and SIMCI collaboration is the ability to initialize selected simulations and their C4I interfaces with the same data used to initialize the tactical C4I systems. This leads to a significant reduction in simulation preparation time and resources, reduced opportunities for data inconsistencies, and improved interoperability between simulations, their C4I interfaces, and the tactical C4I systems.

ACSIS is operational today in the CTSF at Fort Hood and it has been used to produce JCDB data loads for Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). ACSIS has also been used to produce initialization files for RTM (CBS) during the recent Victory Scrimmage 03 exercise.

Future phases of the Initialization Capability (IC) are planned to hand over the program to a lead PM, increase the robustness of the ACSIS database into an IC Data Repository (ICDR), and develop better tools that the Army warfighters can use to initialize and reconfigure C4I systems and simulations in the field between sister Services and coalition forces.

As the Army develops the digital C4I and Modeling and Simulation (M&S) systems that will support the Future Combat Systems (FCS) and the Objective Force

(OF), the alignment of their respective data models will mitigate many synchronization issues experienced today. Regardless, there will be a continued need for an Initialization Capability (IC) and many of the lessons learned from this current effort will be useful to both the FCS and the OF.

Although, we have addressed ACSIS as an Army-specific example of C4I and simulation StartEx integration, our belief is that the principles and architecture described here are applicable to C4I and simulation integration for any force or combination of forces.

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ACRONYMS AND ABBREVIATIONS

AADS-UP	ACSIS Authoritative Data Source-Update Process
ABCS	Army Battle Command System
ACSIS	Army C4I and Simulation Initialization System
AFATDS	Advanced Field Artillery Tactical Data System (Fire Support C2 system)
ARL:UT	Applied Research Laboratories: The University of Texas in Austin
ASAS	All Source Analysis System (Intel system)
BAS	Battlefield Automated System
BDE	Brigade
BN	Battalion
C2	Command and Control
C2R	Command and Control Registry
C3T	Command, Control, Communications Tactical
C4I	Command, Control, Communications, Computers, and Intelligence
CBS	Corps Battle Simulation
CCTT	Close Combat Tactical Trainer (virtual simulation systems)
CM	Configuration Management
COA	Course of Action
COP	Common Operational Picture
CP	Command Post
CTSF	Central Technical Support Facility (Fort Hood, TX)
DAUVS	Digital Army USMTF VMF Stimulators
DB	Database
DBST	Digital Battlestaff Sustainment Trainer (federation of simulations and C4I interfaces)
DIF	Data Interchange Format
DMPRC	Digital Multi-Purpose Range Complex (live fire range for digitized forces)
DMSO	Defense Modeling and Simulation Office
EADSIM	Extended Air Defense Simulation (air, air defense, airborne sensor simulation system)
EPIU	Enhanced Protocol Interface Unit
EPLRS	Enhanced Position Location Reporting System (digital data radio system)
ETSIU	Enhanced Tactical Simulation Interface Unit
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat System
FDC	Fire Direction Center
FIO	Force XXI Integration Office (PEO C3T)
FireSim XXI	Fire Simulation XXI (Fire Support simulation system)
FSE	Fire Support Element
FTI	Fixed Tactical Internet
GSORTS	Global Status of Resources and Training System
GUI	Graphical User Interface
IC	Initialization Capability
ICDR	Initialization Capability Data Repository
IOC	Initial Operational Capability
IP	Internet Protocol
JCATS	Joint Conflict and Tactical Simulation (simulation system)
Janus	Janus (simulation system)

JCDB	Joint Common Database
JMUL	Joint Master Unit List
JSID	Joint System Initialization Database
LAN	Local Area Network
LCN	Logical Channel Number (EPLRS network)
LDIF	LDAP Data Interchange Format
LDR	Leader
LTI	Lower Tactical Internet
M&S	Modeling and Simulation
MCS	Maneuver Control System
MTOE	Modified Table of Organizations and Equipment
NTC	National Training Center
NTDR	Near Term Digital Radio (digital data radio system)
OEF	Operation Enduring Freedom
OF	Objective Force
OFF	Officer
OIF	Operation Iraqi Freedom
ORG ID	Organization Identifier
OneSAF	One Semi-Automated Force (simulation system)
OPORD	Operations Order
PdM	Product Manager
PEO C3T	Program Executive Office Command, Control, Communications Tactical
PM	Program Manager
RS ID	Radio Set Identifier (EPLRS network)
RTM (CBS)	Run Time Manager (Corps Battle Simulation)
S2	Military Intelligence officer, cell, section
SA	System Architecture
SIMCI	Simulation to C4I interoperability
SINCGARS	Single Channel Ground and Airborne Radio System (voice and digital radio system)
SOP	Standing Operating Procedure
SQD	Squad
StartEx	Start of Exercise
TI	Tactical Internet
TIMS	Tactical Internet Management System
TOC	Tactical Operations Center
TTP	Tactics, Techniques, and Procedures
UOB-DAT	Unit Order of Battle Data Access Tool
URN	Unit Reference Number
USAFMSA	United States Army Force Management Support Agency
USMTF	United States Message Text Format
UTI	Upper Tactical Internet
UTO	Unit Task Organization
VMF	Variable Message Format
V&V	Verification and Validation
WARSIM	Warfighter's Simulation (simulation system)
XML	Extensible Markup Language