OneSAF Testbed Baseline 1.0

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ABSTRACT

Although it will replace ModSAF, the OneSAF Testbed Baseline (OTB) is itself an interim product. It represents a bridge program between legacy Computer Generated Forces (CGFs) and the OneSAF Objective System (OOS), a new Department of the Army development program managed by STRICOM that will be a composable, next generation Computer Generated Force. The OOS will represent a full range of operations, systems, and command and control processes from individual combatant and platform to the battalion level.

The Army chose to develop the OTB well prior to the award of the OOS contract to explore potential risk mitigation targets and to examine what legacy artifacts should be directed for reuse and what functionality should be developed under the new contract. In addition, they chose to refine the concept of collaborative development; i.e. customers and developers working side by side. Consequently, the OTB is being used to provide integration, test and user feedback of technology developments and methods for the objective system. OTB provides a type of simulation test-bed never before used by the Army. Over 28 Department of Defense agencies representing the Army, Joint and Coalition organizations provide input and feedback from the various modeling and simulation domains, and combat development organizations. OTB 1.0 was released in December 2000 and is the official replacement for ModSAF The OTB provides a variable level of fidelity that supports ACR, RDA, and TEMO. This paper describes the key technological advances made during the course of the OTB 1.0 development, ranging from Architectural innovations to the complete rewriting of functional areas, e.g. Artillery and Combat Engineering (minefields). In addition to the advances in technology, there were breakthroughs in the software development process itself. The final section of the paper includes some of the key areas where OTB 1.0 is already being employed as an analysis tool and/or low-overhead driver of C4I devices.

ABOUT THE AUTHORS:

Lieutenant Colonel Tom Coffman is the Product Manager for the One Semi-Automated Forces (OneSAF) program. He is an Army Acquisition Corps officer assigned to the the Simulation, Training, and Instrumentation Command (STRICOM), with Level III certification in Program Management and Level II certification in Research and Development. He entered the Army in 1983, receiving an ROTC commission into the Transportation Corps from the University of Dayton. At the University of Dayton he earned a Bachelor of Science degree in Business Management. Later, he earned a Master of Science degree in Business Administration from Boston University.

John Logsdon is currently the Deputy Product Manager for the One Semi Automated Forces (OneSAF) project within the U.S. Army Simulation Training and Instrumentation Command (STRICOM). Since joining the government in 1982, he has worked as the PM/PD on projects ranging from the U.S. Navy's F-14D(R) & F-14A-B Upgrade projects to the U.S. Army's Corps Battle Simulation (CBS), Aggregate Level Simulation Protocol (ALSP) and Warfighters Simulation (WARSIM) projects. He holds a Bachelor's Degree in Electrical Engineering from West Virginia Institute of Technology.

Jim Duke is a Project Director for Science Applications International Corporation (SAIC) with over 16 years experience in the development of software applications and systems. He has been a member of the OTB development team for the past two years serving in increasing levels of responsibility as a senior software engineer, as the lead integrator, and finally as Project Director for the OTB. Prior to joining SAIC, Mr. Duke was a principal software engineer for an optical storage company where he led the development of several award winning commercial optical storage products. He holds a Bachelor s Degree in Computer Science from the University of Central Florida.

Bryan Cole s current role is SAIC s Program Manager for OneSAF. He entered the Defense Contracting business in 1983 as an Electronics Buyer. Mr. Cole has steadily moved into roles of increasing complexity and responsibility ranging from small software program development to his current role as PM OneSAF.
He holds a Bachelor s Degree in Psychology from Southern Illinois University and commenced the pursuit of a second Bachelor s Degree (Computer Science) in 1984.

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TESTBED BASELINE (OBT) BACKGROUND

During the summer of 1997, the U.S. Army Simulation, Training and Instrumentation Command (STRICOM) supported an analysis effort to study the potential architectural implications of the One Semi-Automated Forces (OneSAF) operational requirements. The OneSAF Operational Requirements Document (ORD), developed by the government s OneSAF Integrated Concept Team, defines OneSAF as a composable, next generation CGF that can represent a full range of operations, systems, and control processes from individual combatant and platform to battalion level, with a variable level of fidelity that supports all M&S domains [1]. The analysis effort [2] concluded that an evolutionary approach using Modular Semi-Automated Forces (ModSAF) or the Close Combat Tactical Trainer Semi-Automated Forces (CCTT SAF) would not satisfy the variety of OneSAF uses, nor would it be a maintainable or extensible solution. The analysis further concluded that a new OneSAF architecture should be developed to maximize the reuse of legacy SAF development experience, concepts, design, and code at every opportunity. However, to reduce the technical risks of the architecture development, research and a thorough domain analysis should be conducted prior to this development.

Due to programmatic constraints, the Army accepted the technical recommendation but was not able to execute the recommendation in the near term. The Army Model and Simulation Executive Council (AMSEC) directed a OneSAF development plan that focuses the near term evolution of an existing SAF system, either ModSAF or CCTT SAF as depicted in Figure 1.

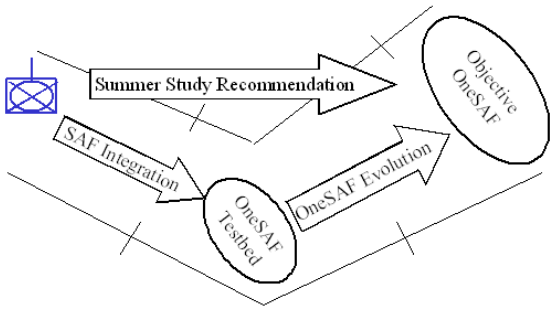

Figure 1 OneSAF Avenues of Approach

This near term OneSAF Testbed will be used to support research and development for the next generation OneSAF architecture experiments. In March 1998, STRICOM supported a five-week analysis effort to develop a recommendation of the SAF system to be used as the baseline for integrating ModSAF and CCTT SAF capabilities into a OneSAF Testbed baseline. Given the prioritization to provide the follow capabilities, this analysis [3] recommended an integration effort starting from the ModSAF baseline:

- A similar capacity for plug and play (i.e., extensibility) as provided by CCTT SAF and ModSAF.
- A capacity to be extended toward providing a battalion level behavior Application Program Interface (API).
- A capacity to support research and development experimentation associated with the OneSAF object architecture using current SAF capabilities.
- A breadth of modeling capability as provided by CCTT SAF and ModSAF.

- A training capability as provided by CCTT SAF and ModSAF.

The recommended approach was to build the OneSAF Testbed using the ModSAF architecture and models. The integration approach included selectively re-engineering CCTT SAF models and architectural characteristics into this C language baseline and extending the ModSAF architecture through software engineering enhancements. After successful Government Acceptance Testing, OTB 1.0 was released in December 2000 and is the official replacement for ModSAF. The international version of the OTB completed development in the summer of 2001.

SOFTWARE DEVELOPMENT PROCESS AND OTB 1.0

The user domain representatives were regularly present in the development facility during requirements analysis, design, coding and unit test, as well as system integration and acceptance testing. This daily involvement of the user facilitated a breakthrough in the software development process in terms of shortening the entire software development cycle and reducing the number of induced defects. Having the user regularly involved streamlined the development process through minimal rework associated with ambiguous requirements and/or incorrect interpretation by the developer. This process resulted in the OTB operating the way the users wanted it to, as well as the way the software developer expected it to. User involvement throughout development lifecycle was such an effective concept that the OOS will be developed using the same paradigm.

ARCHITECTURAL ADVANCEMENTS FOR OTB 1.0

As part of its mission of experimenting with new technologies, several architectural enhancements were introduced to OTB 1.0. These included:

- **Dynamic Unit Editor (DUE):** This is the capability to dynamically create unit definitions, via a Java editor. The key architectural enhancement DUE introduced was the ability to support dynamic unit editing: new units could be introduced while OTB was active. In addition, new unit definitions would automatically be disseminated across all simulators in a distributed environment. This is a significant enhancement because problems of managing configuration and model data in a distributed simulation environment are common. This automatic dissemination technology eliminates this problem. Thus far only DUE uses this concept of automatic dissemination of data, but it could readily be applied to other areas as well.

- **Runtime Data Collection (RDC):** The ability to monitor the values of internal, transient data of multiple networked entities as a scenario is running, via the (largely Java) Runtime Data Collection system. One of the key features of this tool is that all model data are automatically made accessible while OTB is built. No programmer intervention is required. Whenever a new model is introduced, or an old model is modified, the model data are automatically added to RDC. In many ways the RDC is a self-maintaining tool.

- **Portable Scenarios:** An ASCII-based Portable Scenario Format, allowing scenarios from an old version of the OTB to be used in a later version of the OTB.

- **Dynamically Loadable Modules (DLM):** The capability to dynamically load SAF libraries provides an architecture for system composability and better user customization. The potential of this capability is only partially being exploited in OTB version 1.0. DLM s provide a foundation upon which can be built: 1) the ability to upgrade models; 2) the ability to load alternate implementations of models; and 3) the ability to introduce new models. All these abilities can be performed while the simulation is running.

FUNCTIONAL ENHANCEMENTS FOR OTB 1.0

The key functional areas improved are as indicated below. It was these areas in particular where the on-site presence of Subject Matter Experts was particularly effective in the efficient development of the software.

- **Improved Visual Detection:** Support for peripheral vision was added in order to more accurately model visual detections. While peripheral vision is not capable of detecting or identifying targets, it is used to cue off of fires and detonations when searching for enemy. These cueing events influence what areas of the scanning area are examined next. In addition, the visual scanning model was enhanced to scan in three dimensions, enhancing the sensors ability to detect air threats from the ground and ground threats from the air.

- **Improved Rotary Wing Aircraft (RWA):** Provides improved RWA dynamics and behaviors, including multiple-concurrent Hellfire engagement. The RWA pilot model was enhanced to maintain altitude and speed, enhancing support for support Nap-Of-Earth (NOE) flight. The pilot model examines the terrain along the flight path and anticipates ridges and valleys in order to prevent ballooning over ridges and crashing in valleys.

- **Improved Ground Maneuver:** Provides improved station keeping at all echelon levels, fundamentally better maneuver around obstacles and through choke points, and more appropriate over watch behaviors. In the case of choke points, the terrain is examined and if a choke point is detected in the route ahead (such as a bridge or a narrow pass) the unit will converge from an open area formation (such as a wedge formation) into a column formation. Once the unit has exited the choke point, it returns to the former open area formation.

- **Improved Target Acquisition:** Improved target selection, accounting for enemy distance, lethality, movement, etc., instead of just priority. This improved target acquisition algorithm is also integrated into the target coordination code so that a unit (platoon or company) will engage an enemy unit much more effectively, expending fewer munitions and eliminating high priority threats more quickly.

- **Improved Lethality/Vulnerability data:** The lethality/vulnerability data for nearly every vehicle was examined and updated by AMSAA.

- **Improved Artillery:** The artillery tool was enhanced to greatly simplify the task of assigning missions to artillery units by only showing those fields that apply to the particular mission type and unit. Munition effects tables were updated to reflect the correct BLUFOR doctrine and OPFOR doctrine as expressed in the Artillery Field Manuals and OPFOR Battle Book from the Command and General Staff College. Mission parameters were rewritten to match doctrinal Forward Observer target descriptions. Stored fire missions can now be saved to scenarios and can be individualized for each artillery unit. Artillery units were revised to match doctrinal organizations, with the correct radio networks constructed.

- **Improved Combat Engineering:** The minefield simulation was optimized and modified to match correct Army doctrine as expressed in Army Field Manuals. The optimizations reduced the simulation load of minefields by an order of magnitude — greatly increasing the number of minefields that can reasonably be fielded in an exercise. In addition the minefield breaching behaviors were revised and corrected to more accurately reflect Army doctrine as expressed in Army Field Manuals.

CANDIDATES FOR OTB 2.0 INTEGRATION

Efforts are currently underway to define the content of the next version release of the OTB. Candidate functional improvements are being evaluated from a wide range of on-going user development efforts. These include, but are not limited to:

a. Joint Virtual Battlespace (JVB) efforts being executed by the Joint Precision Strike Demonstration (JPSD) Project Office in support of analytical efforts for the Future Combat System (FCS).

b. Distance Learning efforts being executed in support of the Iowa National Guard and Digital Divisions 2 through N ((DD2-N) program.

c. Mounted Warfare Test Bed (MWTB) efforts conducted at Fort Knox by the Mounted Maneuver Battlespace Lab.

d. Warfighter s Simulation (WARSIM) 2000 Command, Control, Communications, Computers and Intelligence (C4I) efforts.

e. OneSAF Objective System (OOS) efforts in the pre- and post-exercise tool areas.

f. Baseline merge efforts with Joint SAF (JSAF) in support of establishment of the Modeling and Simulation federation infrastructure for the Millennium Challenge 02 (MC02) exercise.

g. International efforts conducted in support of the Ministries of Defense for the Slovak Republic and the Czech Republic.

Specific functional capability highlights from the major efforts identified above include:

- **Dismounted Infantry Semi-Automated Forces (DISAF)**: Open terrain behaviors, furniture modeling, aural sensing, hand grenades, remembered threats, advanced collision dynamics, automated clear room, automated tactical movement, and underground tunnels.

- **Multisided Forces:** Capability to have more than two (2) sides on the battlefield.

- **Military Operations in Urban Terrain (MOUT) Virtual Emergency Response Training System (VERTS):** Weapons of mass destruction and ability to train first responders.

- **Composable Behaviors:** Ability to compose complex behaviors from a suite of primitives, for wheeled and tracked vehicles, artillery and rotary wing aircraft.

- **Fort Knox Toolkit:** The Mounted Warfare Test Bed (MWTB) added a large number us useful PVD enhancements: Find Tool, Global Permission Tool, Unit Editor (modified), PVD Controls Editor (modified), Laser Designate Tool, Gun Tool, etc. They also developed an extensive list of additional models to include: Elevating Mast, Cued Sensors, Effect of Woods on Sensors, Effect of Woods on Mobility, Mounted Infantry Don t See, Radar Based on Target Size, Maximum Speed for FWA, Modifier for Direct and Indirect Fire PKs, Digin-Self behavior

- **Replicatibility:** A user interface for the setup of multiple runs of the same scenario (for analysis purposes).

- **OTB International Graphical User Interface (GUI):** A modular approach to instantiating the GUI in foreign languages.

These functional capabilities will be integrated, tested and released through the same Configuration Management (CM) baseline process utilized to create OTB V1.0. OTB V2.0 will represent the first significant re-integration of user functionality to be accomplished as originally envisioned under the ModSAF/OTB Distribution Agreement (DA) process. It is hoped that this will provide significant lessons learned towards establishing a viable process for the promotion and execution of this approach with the OneSAF Objective System (OOS). The resulting baseline will also take a significant step towards meeting the top level U.S. Army goals for OTB to provide both:

a. An M&S tool that can meet the existing user base requirements.

b. A test bed for the components and modeling concepts that will be utilized by the next generation OOS.

OTB'S ROLE IN THE ARMY TODAY

JVB Involvement

The OTB is playing a key role in the JVB project through its support of the majority of the ground vehicles in the exercise and its support of the FCS vehicles. The key word in describing OTB s involvement in JVB is *composability*. In JVB, vehicles can be composed of a platform model run by the OTB, sensor models run by high fidelity sensor models provided by Department of Energy (DOE) labs, composable behaviors defined by OTB tools, situational awareness models developed by JPSD, and high fidelity route planning services provided by yet another model. OTB forms the framework upon which this level of composable simulations is made possible. Users can choose to use models completely native to OTB, or any combination of native models and external models.

Distance Learning and the Iowa National Guard

The Distance Learning for the Iowa National Guard program is a proof of concept initiative to determine if it is feasible to train students in multiple remote locations on the use of various tactical C4I equipment. The OTB is used to create the virtual world. During the course of a scenario, various OTB entities generate C4I messages that in turn stimulate the C4I equipment being studied in the distance-learning environment.

Millennium Challenge 2002

Congress mandated and the Secretary of Defense directed that the USJFCOM conduct a joint field experiment in the July/August 2002 timeframe. This experiment has been designated the Millennium Challenge 2002 (MC02) and is a large scale, live, virtual and constructive joint field experiment/demonstration exercise. The following service elements are participating: Army Medium Brigades, Navy Forward from the Sea, Air Force Expeditionary Forces, USMC Expeditionary Maneuver and Special Operations Forces. More information can be found at (www.jfcom.mil).

Each service branch is contributing to this exercise. The Army is using Eagle integrated with OTB using the Simulation Interface Unit (SIU) to support Aggregation/Disaggregation. Eagle/OTB will interoperate with other simulations from other services including: JSAF, JCATS, and AWSIM.

THE WAY AHEAD

Although it has replaced ModSAF, the OTB is itself an interim product. It represents the bridge program between legacy Computer Generated Forces (CGFs) and the OOS. The OOS will represent a full range of operations, systems, and command and control processes from individual combatant and platform to battalion level. It will provide a variable level of fidelity that supports ACR, RDA, and TEMO. OOS will accurately and effectively represent specific activities of ground warfare (engagement and maneuver), C4I, CS, and CSS. It will also employ appropriate representations of the physical environment and its effect on simulated activities and behaviors. The OOS will be procured as a series of task orders under the new STRICOM Omnibus Contract (STOC) Constructive Lot. STRICOM s PM One-SAF office will provide capability to the field in a series of block releases, with Initial Operational Capability in FY03 and Full Operational Capability in FY05.

REFERENCES

[1] One Semi-Automated Forces (OneSAF) Requirements Document , OneSAF Integrated Concept Team Requirements Subgroup, August 22, 1997.

[2] OneSAF Analysis, Final Report , Document Number, SAIC-98/7768&00, Science Application International Corporation, September 26, 1997.

[3] OneSAF Baseline Assessment, Final Report , Document Number, ADST-II-CDRL-ONESAF-9800101, Lockheed Martin Corporation, May 8 1998.