AIR SYNTHETIC FORCE DEVELOPMENT

Edward P. Harvey
BMH Associates, Inc.
Norfolk, Virginia

CDR P.A. Feldmann, USN
Advanced Research Projects Agency
Arlington, Virginia

ABSTRACT

Synthetic Force (SF) simulation systems for the Army, Navy, Marine Corps, and Air Force are being developed by the Advanced Research Projects Agency (ARPA) to support the Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD). These four SF projects are based on the Modular Semi-Automated Forces (ModSAF) Computer Generated Force (CGF) system. Intelligent Force (IFOR) and Command Force (CFOR) simulations are also being developed to increase the level of automation and enhance the quality of behavior exhibited by SF entities and command entities. In addition, ModSAF-based Air SF simulations are being developed to provide the air entities for each service SF project. The goal of the Air SF effort is to develop air entity simulations which are compliant with Distributed Interactive Simulation (DIS) networking protocols, provide entity level resolution of battlespace interactions, and can be validated for use during Joint Task Force training exercises.

This paper will introduce the ARPA SF development program, then describe the Air SF development effort which supports the program including system design and functionality, and in summary, describe the use of Air SF during the STOW-E and Kernel Blitz training exercises.

BIOGRAPHIES

Mr. Edward P. Harvey is employed by BMH Associates, Inc., a simulation and training systems engineering company specializing in Advanced Distributed Simulation technology development. He has been involved on ADS efforts including SIMNET, HY-DY, ODIN, WISSARD, ModSAF, IFOR, CFOR, and the Synthetic Force development programs.

CDR P.A. Feldmann, USN is the ARPA Information Systems Office Synthetic Forces Program Manager. She is tasked with ensuring behaviorally correct computer generated forces are represented in the battlespace for the ARPA Synthetic Theater of War program.

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Edward P. Harvey
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INTRODUCTION

The ARPA Synthetic Force (SF) development program consists of the U.S. Army (USA), U.S. Navy (USN), U.S. Marine Corps (USMC), and U.S. Air Force (USAF) SF projects; the Intelligent Force (IFOR) project; and the Command Force (CFOR) project. The four service SF projects are responsible for development of the ground vehicle, ship, Individual Combatant (IC), and aircraft entities which may be assigned to the various combat organizations within a Joint Task Force (JTF). The IFOR project is responsible for development of autonomous fixed- and rotary-wing tactical aircraft simulations. The CFOR project is responsible for development of decision making / planning command entities. Figure 1 shows the relationships between the SF development program projects.

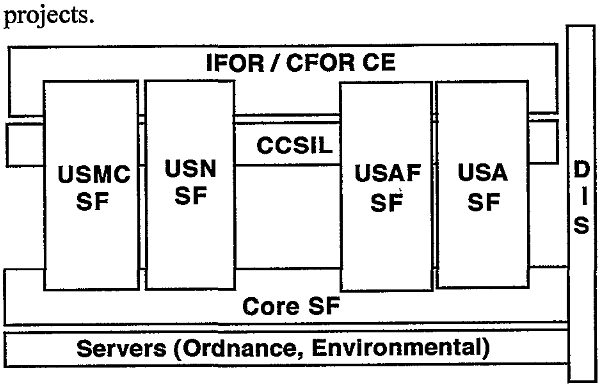

Figure 1 - SF Development Program Architecture

The purpose of the SF development program is to provide Computer Generated Force (CGF) systems for the Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD) being developed by ARPA for the U.S. Atlantic Command (USACOM). STOW '97 is a key milestone within the ARPA STOW program which is a part of the larger ARPA Advanced Distributed Simulation (ADS) program. The goals of the STOW program identified in the STOW ACTD Management Plan[1] are to:

- Improve the quality of simulations including entity resolution, performance, and environmental representations;
- Improve simulation training effectiveness and flexibility to include interfaces with operational C^4I systems, and integration of live, virtual, and constructive simulations;
- Reduce the overhead costs of simulation through use of knowledge-based, semi-autonomous and autonomous force representations, faster environmental database builds, and improved information transfer;
- Improve after action analytical tools;
- Achieve simulation driven crisis rehearsal initial operations capability; and
- Provide an operational prototype for USACOM's use in joint training and mission rehearsals.

STOW '97 will be conducted in three phases. Phase I consists of technology and process development in parallel with a series of engineering demonstrations to validate and integrate Distributed Interactive Simulation (DIS) technologies in preparation for joint applications demonstrations in STOW '97. Phase I will continue through FY96. Phase II will consist of a series of demonstrations of STOW technology in joint and service applications with USACOM's operational and tactical level joint exercise programs in FY97. Phase III will involve support for USACOM training subsequent to the STOW '97 demonstration.

In order to provide the number of simulated entities potentially required to support STOW '97, ARPA SF systems are being developed to operate autonomously at the highest level attainable in the operational chain of command below the level of the training audience. For example, the most cost-effective way to train a battalion commander and his staff would be to use SF simulations which validly represent interactions from the company level to the battalion, at the company level, and below. Some of the SF systems design features which allow autonomous operations at echelons above the entity level were identified in the DMSO Survey of Semi-automated Forces[2] and include:

- Explicit capture and representation of command and control information,
- Standardized messages and formats for command and control across all echelons,
- Modular, reconfigurable entity representations,
- Distributed storage of state information, and

- Arbitration schemes for resolving competing goals.

The remainder of this Introduction section will familiarize the reader with the scope of the ARPA SF development program by briefly describing each SF project. The following section narrows the focus of the paper to the development of air entities in support of the service SF projects and the IFOR project. The final section describes the real world use of Air SF systems during the STOW - Europe (STOW-E) and Kernel Blitz training exercises.

Modular Semi-Automated Forces (ModSAF)

ModSAF is a direct outgrowth of the Semi-Automated Force (SAFOR) simulation system developed during the USA/DARPA Simulation Networking (SIMNET) program in the late 1980s. Figure 2 shows the evolution from Semi-Automated Forces (SAFOR) to ModSAF. SAFOR provided a cost-effective capability to populate a battlefield with friendly and opposing forces under control of human commanders to augment the number of available SIMNET manned simulators. SAFOR was used as the basis for development of the initial version of ModSAF to support the ARPA Intelligent Force (IFOR) / What If Simulation System for Advanced Research and Development (WISSARD) project. ModSAF initially provided a set of tactical aircraft entities capable of performing beyond visual range air-to-air combat and has been since upgraded to include the capabilities of the original SAFOR system plus enhancements to horizontally expand the battlefield. Behaviors for ModSAF entities are implemented using rule sets called tasks which are analogous to the Combat Instruction Sets (CISs) which were used for SAFOR behaviors and are being used for the USA Close Combat Tactical Trainer (CCTT) program. An entity control interface implemented in ModSAF provides the means for vehicle level control by IFOR simulations such as the Soar-Tacair agent which bypasses ModSAF task behaviors and uses AI techniques for representation of entity behavior.

Since its initial release in December 1992, ModSAF has been upgraded through the Army's Simulation, Training and Instrumentation Command (STRICOM). The latest ModSAF version is 1.5.1 which includes various types of friendly and adversary tanks, armored personnel carriers, dismounted infantry, artillery, air defense weapons, helicopters, command and control vehicles, fuel vehicles, supply vehicles, tracked recovery vehicles, bridging equipment, mine clearing equipment, and tactical aircraft.

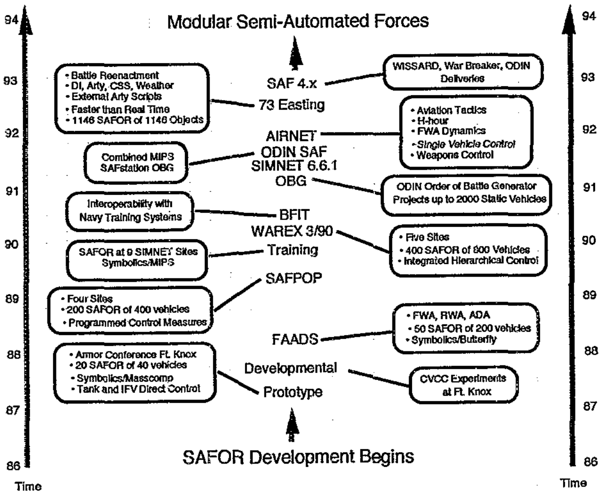

Figure 2 - SAFOR Evolution to ModSAF

ModSAF was the initial core software system for the ARPA SF program. Service specific SF systems based on ModSAF are being developed for use in the STOW '97 demonstration and subsequent training exercises. The decision was made to develop service unique versions of ModSAF in order to gain validation for SF software as efficiently as possible. Only those behaviors which pertain to a given service's simulation needs will be included in that service's SF system.

The Applied Research Laboratories: University of Texas (ARL:UT), Austin, TX, is tasked with investigating and developing performance enhancements to ModSAF, and to implement a configuration management system which supports verification and validation of resulting SF software. Core components from ModSAF (networking, optimization, environmental effects, etc.) will be maintained by ARL:UT in the form of a Core SF system. Core SF will evolve to conform with the High Level Architecture and potentially provide candidate SF systems for JSIMS. ARL:UT will serve as the focal point for release of ARPA SF project software as it matures.

USA SF Project

The USA SF project is the continuation of ModSAF development. The resulting USA SF system will incorporate the ARL:UT Core SF enhancements and an interface for integration of the Command Entities developed during the CFOR projects. The goal for USA SF is to represent a Heavy Brigade for STOW '97. STRICOM assumed responsibility for USA SF project management.

USN SF Project

The purpose of the Navy SF project is to develop the ship, submarine, and aircraft entities which form a Carrier Battle Group (CVBG) and Amphibious Ready Group (ARG). CVBGs and ARGs are the combat organizations on which operational employment of Naval forces for conduct of littoral warfare is based. The Naval Command, Control & Ocean Surveillance Center, RDT&E Division (NRaD), San Diego, CA, is responsible for development of Navy SF. USN SF entities under development by NRaD include the Ticonderoga class Baseline 4 Aegis Guided Missile Cruiser, the Arleigh Burke class Aegis Guided Missile Destroyer, the Nimitz class Aircraft Carrier, the Spruance class Destroyer, the Los Angeles class Attack Submarine, and the Supply class Fast Combat Support Ship for the CVBG; and the Wasp class Amphibious Assault Ship, the Whidbey Island class Dock Landing Ship, and the Multi-Purpose Amphibious Ship for the ARG. Additional USN SF entities being developed which are not organic CVBG or ARG assets include the Avenger class Mine Countermeasures Vessel and the Osprey class Coastal Minehunter. Neutral ships including commercial tankers, merchant vessels, and fishing craft; and adversary ships and submarines will also be developed during the USN SF project.

The development strategy for USN SF is to create the Aegis Guided Missile Cruiser using existing ModSAF simulation models to the maximum extent possible. Relevant ModSAF models will be modified for simulation of ship systems, and system models which do not exist in ModSAF will be developed. For example, the ModSAF air-to-air radar model was modified to include the effects of earth curvature on surface and air target detection and used as the initial Aegis cruiser radar.

Simulations for each class of ship and submarine will be based upon the Aegis cruiser simulation. This is the most efficient development strategy for USN SF as the Aegis cruiser is the most complex USN SF entity and includes the majority of the systems of the other classes of ships being developed. The Aegis cruiser even has a high degree of commonality with an SSN 688 class submarine. The cruiser and submarine both employ active and passive sonar sensors, engage surface targets with the Harpoon anti-ship missile, conduct Strike Warfare missions with the Tomahawk Land Attack Missile, and engage surface and subsurface craft with torpedoes. Once the Aegis cruiser is complete, the other USN SF entities are easily modeled by eliminating Aegis cruiser systems which are not applicable and by reparameterizing the remaining system models to exhibit proper performance characteristics.

A similar development strategy is being used for representation of mission behaviors for each ship class. The doctrinal missions areas for employment of ships include Anti-Air Warfare (AAW), Anti-Surface Warfare (ASUW), Anti-Submarine Warfare (ASW), Strike Warfare (STW), Command and Control Warfare (C2W), Mine Warfare (MIW), and Amphibious Warfare (AMW). The component tasks for each mission area are similar for those classes of ships capable of performing within a given mission area due to commonality of sensors, weapons, and C^4I systems across ship classes. At the lowest level of granularity, mission task behavior for a ship entity is accurately represented by a sequence of system outputs which result in transmission of entity state, event, and data information over the network. The entity state and event data provide the means to portray the changes in "appearance" of an entity which are observable, and data information transmitted over the network permits integration of entities and weapon simulations. The same behavioral representation approach, once developed, can be used for each subsequent class of ships which have the capability to perform the same missions.

USMC SF Project

The primary purpose of the USMC SF project is to develop the various types of entities, Individual Combatants (ICs), ground vehicles, and aircraft which may comprise a Marine Air Ground Task Force (MAGTF). The Marine Expeditionary Force (MEF) - Forward (FWD) is the USMC combat organization selected for modeling for the STOW '97 demonstration as it represents any of the various sized Marine MAGTFs likely to be assigned to a JTF operation. NRaD is also responsible for USMC SF development.

The development strategy for USMC SF is based on building functionality from the bottom up starting with the four man Fire Team as the lowest level of IC granularity on the battlefield. Higher echelon unit representations are combinations of Fire Team ICs with appropriate command and fire support elements. Three Fire Teams plus a Squad Leader form a Squad; three Squads plus a Platoon Leader form a Platoon; three Platoons, a Weapons Platoon, and a Company Commander with a Headquarters Section form a Company; and three Companies, a Weapons Company, and a Headquarters and Service Company which includes a Battalion Commander and his staff, form a Battalion. Fire Support Units such as mortar teams, machine gun teams, and anti-tank teams are also being developed.

The Ground Combat Element (GCE) of the MAGTF is composed of a reinforced regiment consisting of three

Infantry Battalions which are the primary maneuver elements of the MEF (FWD), a Headquarters Company which includes the Regimental Commander and his staff, a Reconnaissance Platoon, and an Anti-Tank Platoon. Other elements reinforcing the Regiment include an Artillery Battalion, Tank Company, Combat Engineer Company, Assault Amphibian Company, and Light Armored Reconnaissance Company.

The MAGTF's Aviation Combat Element (ACE) Assault Helicopters (AH-1W), Assault Support Helicopters (CH-46 and CH-53), Utility Helicopters (UH-1N), Refueler Aircraft (KC-130), Attack Aircraft (AV-8B), Fighter/Attack Aircraft (F/A-18), and Air Defense assets (I-Hawk and Stinger) will also be developed.

The goal for the USMC SF project is to validly represent IC behavior up to the battalion level for missions including amphibious assault, movement to contact, attack (day/night and mechanized), consolidation, defense, and patrol. Fire Teams and Squads will be represented with SF-based IC simulations, and platoon and company commanders will be represented by Command Force (CFOR) simulations. ICs developed during the USMC SF project should also prove useful as a basis for simulation of Military Operations in Built-up Areas (MOBA).

USAF SF Project

The USAF SF project commenced in June of this year under the management of the USAF Electronic Systems Command (ESC), Hanscom AFB, MA. The purpose of the USAF SF project is to develop SF systems which enhance the capability to train the air warrior. In addition to developing ModSAF-based tactical aircraft simulations, other CGF systems will be investigated including an automated wingman and a warfighter in the loop switchover simulation. These simulations have been selected for their potential to enhance the training effectiveness of manned tactical aircraft simulators. Terrain database requirements for employment of tactical aircraft simulators and the design of an operations control station will also be investigated.

The development strategy for USAF SF is to create the entities required to form Composite Air Wings capable of providing Aerospace Control, Force Application, Situational Awareness/C^3I, and Mobility functions in support of JTF operations.

IFOR Project

The IFOR project commenced in 1993 in conjunction with development of the WISSARD testbed where knowledge acquisition activities which support IFOR are conducted. The objective for the IFOR project is to develop SF simulations with an order of magnitude increase in capability to autonomously portray human-like behavior in a complex tactical environment. IFOR agents are being developed by a university consortium which includes the University of Michigan (UM), University of Southern California (USC), and Carnegie-Mellon University and is headed by Dr. John Laird at UM and Dr. Paul Rosenbloom at USC. IFOR agents are developed using the Soar AI language to model tactical aircrew decision making processes which control air vehicles represented by SF. An iterative development process consisting of knowledge acquisition / engineering, software development, and testing is used for the IFOR project.

Initial IFOR Soar agent development was in the beyond visual range air-to-air combat domain. The resulting air-to-air agent software was used to develop both an air-to-ground agent and a rotary wing anti-armor agent. A comprehensive description of the IFOR project and the capabilities of the Soar agents can be found in the Spring 1995 AI Magazine[3].

One of the primary goals for the IFOR project is to reduce the cost of large scale simulation exercises by decreasing the number of operators who are required to monitor and control SF systems, while increasing the validity of the combat interactions portrayed at the entity level. Autonomous operation of multi-mission fixed- and rotary-wing aircraft based on Air Tasking Orders disseminated by a Joint Forces Air Component Commander appears achievable for STOW '97 through use of IFOR Soar agents in control of air SF entities.

Command Force (CFOR) Project

The purpose of the CFOR project is to model command and control in a DIS environment in the form of the Command Entities (CEs) which have a physical presence on a battlefield. The initial CFOR CEs under development are an Army Company Team armor commander and a rotary wing anti-armor company commander. Automation of company and battalion level commanders is necessary to reduce the number of human SF system operators required for conduct of large scale simulation exercises.

Each CE is a separate process which models the monitoring and decision making activities of a commander. Figure 3 shows the CE Technical Reference Model which consists of a physical entity in the form of a SF combat vehicle, a CE application, and software services and utilities which integrate the CE with its host combat vehicle. CE developers are only responsible for development of the CE software. SF vehicle software and the information services and utilities which link the combat vehicle with the CE are provided as government furnished software. This allows each CE developer to model command decision making without the need to devote resources for development of the basic SF system infrastructure.

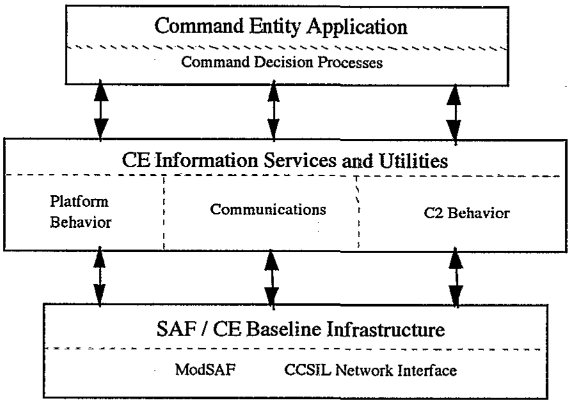

Figure 3 - CFOR CE Technical Reference Model

CEs receive reports from subordinates and orders from superiors through use of a standardized set of messages known as Command and Control Simulation Interface Language (CCSIL). CCSIL message content is embedded within DIS Signal Protocol Data Units (PDUs) for simulated radio frequency transmission over the network. CCSIL message sets have been developed for the armor company commander to support initial CE development, and are being developed for the Anti-Air Warfare (AAW) and Anti-Surface Warfare (ASUW) domains to provide a communications capability for USN SF entities. CCSIL messages will eventually be developed to facilitate command and control for all SF entities currently under development.

AIR SF DEVELOPMENT

Air SF development supports each ARPA SF project by providing the air entities employed by each military service. This approach eliminates duplication of effort and reduces the potential for incompatible air entity system functionalities and behaviors which might adversely affect the capability to validly portray joint interactions for STOW '97. Air entities are much like naval craft in that there is significant system and behavior commonality across the different classes of aircraft whether the aircraft are employed by one of the U.S. military services, an ally air service, or the air force of a potential adversary. An example of mission (behavior) commonality within the strike fighter class of aircraft is shown in Figure 4.

The use of Air SF provides a development base for commencement of USAF SF project activities and allows each of the other SF projects to focus on development of a single class of combat vehicle; ships for USN SF, ICs for USMC SF, and ground vehicles for USA SF.

		STRIKE FIGHTER MISSION				
SERVICE	A/C	CAP	SWEEP	INTER-DICTION	STRAT. ATTACK	CAS
USN	F-14B/D	•	•	•		•
	F/A-18C	•	•	•	•	•
USMC	F/A-18C	•	•	•	•	•
	F/A-18D	•	•	•	•	•
	AV-8B	•				•
USAF	F-15E	•	•	•	•	•
	F-16C	•	•	•		•
THREAT	SU-24	•		•	•	•
	MiG-23	•		•	•	•

Figure 4 - Air Entity Mission Commonality

Air SF Development Plan

The initial version of ModSAF was an air only system developed to provide vehicle level simulations for the Soar IFOR project in the air-to-air domain. Single aircraft tactical behaviors including route following, station keeping, target intercept, and weapons employment were implemented as rule-based tasks. Subsequent enhancements to ModSAF air included single aircraft ground attack tasks and enhancements to the core system such as multicast network support and environmental effects.

ModSAF was selected by the Navy to demonstrate the potential of SF systems in development by ARPA to support training during the Synthetic Theater of War - Europe (STOW-E) exercise in November 1994. Air system enhancements identified as a result of STOW-E experience included removal of ModSAF ground vehicle simulations, expansion of the types of aircraft modeled, and integration of valid guided weapon flyout models. These enhancements were incorporated for the April 1995 USN/USMC Kernel Blitz amphibious training exercise. This new air only ModSAF configuration was the first version of the Air SF.

The Air SF effort includes development of friendly and adversary aircraft and integrated air defense system (IADS) entities to support the service SF projects, development of CCSIL message formats for each air warfare domain, and development of Air Tasking Order (ATO) dissemination and simulation resource management applications. Completion of these tasks rounds out air and IADS entity system and mission behavior capabilities for STOW '97, and improves the autonomous operations capability of the service SF systems.

Air SF Software Validation

The result of the Air SF development effort will be a software configuration for each service SF project that includes entity representations of those aircraft types operated by that service plus a common set of adversary and neutral air entities, IADS entities, and target entities. Partitioning Air SF into service specific software configurations will allow each service to validate the models of the aircraft assigned to that service.

The software development process defined for Air SF includes Requirements, Knowledge Acquisition / Engineering (KA/E), Software Development, and Testing and Validation tasks. Figure 5 is a top level depiction of the SF program software development process used for Air SF development.

Legacy ModSAF air entity system and behavior models will be documented for functionality, and deficiencies will be identified and prioritized for future correction. The KA/E required to support software development will be provided. The resulting software will be internally verified and tested to ensure proper functionality prior to being submitted for service VV&A proponents for validation. The SF software development process is based on the software development process being used by the Army for CCTT.

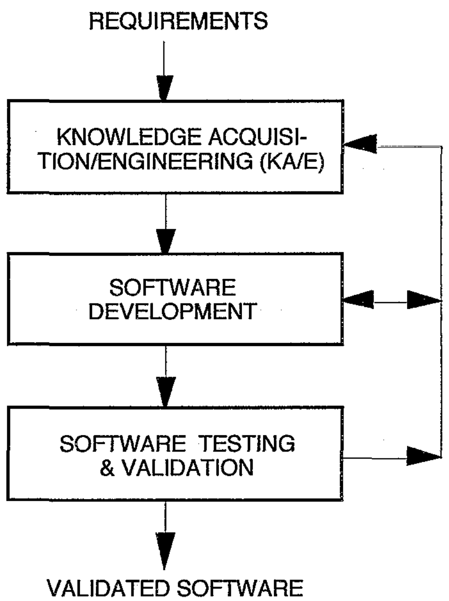

Figure 5 - SF SW Development Process

Air SF System Performance

The main performance area which affects Air SF operations during a training exercise is the ability of a single operator to plan, initialize, monitor, and control multiple aircraft simultaneously. These functions are currently performed using the ModSAF Graphical User Interface (GUI), also known as the SAF Station. The ModSAF GUI has been enhanced for Air SF by removing any feature not associated with air operations and by limiting the entities which are accessible to the operator to just those required for air operations. The Air SF GUI has a mission scripting capability which can be used to create the scenario prior to an exercise according to a schedule of events. It also includes the functionality necessary to rapidly generate air missions in real time should the need arise such as during live Fleet exercises where the inability to generate an unplanned sortie will adversely affect training goals.

Air SF workstation performance with regard to numbers of entities in a training exercise will likely be sufficient for STOW '97 size events of 20,000+ entities of which the majority will be ground combat vehicles. Over 1,800 entities were present on the network for the STOW-E exercise of which approximately 85%-90% were ground combat vehicles. Each Air SF simulator had to process each of those entities while simulating a number of air entities itself. The ModSAF-based Air SF workstations survived being exposed to this entity load and continued to operate and generate 100% of assigned air sorties. Implementation of vehicle class filtering and/or multi-cast will result in an entity load for Air SF during the STOW '97 demonstration similar to that experienced during the STOW-E exercise.

Two other areas of performance which are relevant to Air SF are the number of air entity types supported and the guided weapons simulation capability of Air SF.

Air Entity Types Supported. The capability of an Air SF entity is a function of the performance parameters used in the data files which describe that particular entity. The limited set of air entities delivered with ModSAF has been expanded to include the Navy aircraft assigned to a carrier airwing and its non-organic support air assets such as P-3 patrol aircraft, and a set of adversary air entities identified by the Navy to support Kernel Blitz. Each of these entities were developed by reconfiguring one of the existing ModSAF air entities to exhibit the performance characteristics of the new air entity required to support exercise objectives.

The experience gained manually developing air entities has been applied by Old Dominion University (ODU), Norfolk, VA, to the design and development of an Entity Editor utility. Although the initial version of the Entity Editor will be for fixed wing aircraft, the design is directly applicable to the other SF entity classes including rotary wing aircraft, ship, IC, and ground vehicle. The goal is to use the Entity Editor to develop all aircraft and IADS entities required for STOW '97 for the U.S. military services, the adversary force, and neutral entities such as commercial air by the end of 1995 using existing air entity system models and behaviors. Upgrades to existing system models and behaviors, and missing system models and behaviors will be identified as part of this 1995 effort, and corrected prior to STOW '97.

Guided Weapons Simulation. In order to be accepted by the operational communities for use in training exercises, Air SF must be capable of providing valid guided weapon interactions. The original ModSAF air guided weapon flyouts were sufficient for R&D purposes, but do not adequately model guided weapon performance for use during training exercises. Development and integration of validated guided weapons flyouts within ModSAF was judged to be too costly in time and resources, and could adversely affect the system's capability to generate numbers of entities. For these reasons an alternative approach for guided weapon simulation was identified.

Guided weapon simulations are provided for Air SF through use of an Ordnance Server (OS) process. The OS hosts the same guided weapon flyout models used for live USN Tactical Air Combat Training System (TACTS) and USAF Air Combat Maneuvering Instrumentation (ACMI) training ranges. The TACTS/ACMI guided weapon (munition) models are executed by the OS within a Model Interface Adapter which links the validated models to the OS executive and then to the network. The actual munition model remains unchanged from that which is used on the live training ranges. Figure 6 is a block diagram of the OS.

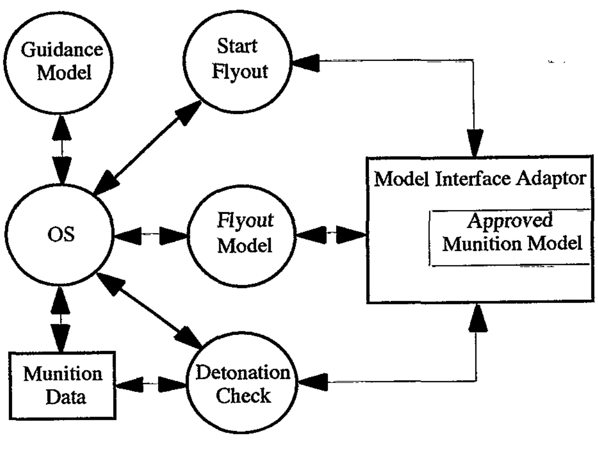

Figure 6 - Ordnance Server

The OS version used during Kernel Blitz supported U.S. air-to-air missiles including the AIM-9M Sidewinder, the AIM-7M Sparrow, the AIM-54 Phoenix, and threat air-to-air missiles with a classification level of SECRET NOFORN or less.

The same OS process can be used for air-to-ground, surface-to-air, and surface-to-surface guided weapons; for countermeasures such as chaff, flares, and decoys; and may be appropriate for ballistic weapons including precision guided and unguided munitions. Additional guided weapons which are being integrated on the OS include the SM-2 Standard surface-to-air missile, an AIM-120 AMRAAM test and evaluation model, the AIM-120 TACTS/ACMI model, a Harpoon anti-ship missile model, and a Tomahawk Land Attack Missile model. The launching entity is responsible for providing weapon flight profile information through transmission of a Data PDU to the OS, initiating weapon launch through transmission of a Fire PDU, and mid-course guidance and/or target illumination through transmission of Emission PDUs. The OS generates the Entity State PDU stream for the guided weapon, Emission PDUs if the weapon employs an active seeker, and a Detonation PDU at weapon-target endgame.

The advantages of the OS include:

- Improved entity behavior representation through use of the valid weapon flyouts which are suitable for training, and in some cases, test and evaluation,
- Increased capability for lower fidelity simulators to validly interact on a network through use of common guided weapons flyouts, and
- More efficient use of workstation computational resources for generation of entities.

STOW-E / KERNEL BLITZ

The Naval Doctrine Command (NDC) was the Navy's executing agent for both STOW-E and Kernel Blitz. Air SF requirements were identified by NDC during STOW-E and incorporated in Air SF by ARPA for Kernel Blitz. An independent evaluation of the potential for DIS technology to support Navy training was performed by the Center for Naval Analyses (CNA) during STOW-E and Kernel Blitz. CNA was tasked to perform in this role by VADM Walter Davis, USN, Chief of Naval Operations, Director, Space and Electronic Warfare, Code N6. CNA published an interim report in December 1994 after STOW-E and released the final report which includes observations from Kernel Blitz in June 1995. The conclusions in the final report are extremely positive regarding the demonstrated potential of DIS technologies including SF systems to support Fleet training.

STOW-E

The purpose of the STOW-E exercise from the Navy's perspective was to evaluate the potential for training using ADS technologies, not to actually conduct training. STOW-E consisted of 21 simulation sites in the U.S. and Europe which included ModSAF air simulations, aggregation models (wargames), manned ground combat vehicle simulators, manned tactical aircraft simulators, an Aegis Guided Missile Cruiser, the Aegis combat training system simulator, Battle Force Tactical Training (BFTT) shore site systems, command and control assets including E-2C and E-3A AWACS simulators, and a live Navy aircraft operating on a TACTS range. Air SF systems located at the WISSARD site at NAS Oceana, VA were used to generate USN air entities and Orange (adversary) air entities for the exercise. Approximately 150 Blue and 120 Orange air SF sorties were generated during the exercise. Air SF interactions included joint strikes with a USAF F-15 simulator located in England, USAF F-16 simulators located in Germany and New Mexico, and a live USN F/A-18 aircraft operating on the Cherry Point, NC TACTS range. These strikes were under the control of an E-2C simulator located at the Naval Air Station Patuxent River, MD, and an E-3 AWACS simulator located at Kirtland AFB, NM.

The CNA interim report[4] issued after STOW-E described the significant potential of DIS technologies to contribute to operational training related to C^3-intensive operations including developing situational awareness, and intra-echelon and cross service coordination. Examples of intra-echelon C^3-intensive operations observed by CNA representatives during STOW-E and mentioned in the report included fighter aircraft on CAP stations under control of E-2C or the Aegis cruiser, and USAF fighters controlled by an E-3 AWACS. Examples of inter-echelon C^3-intensive operations mentioned in the report included USN fighters under the control of the USAF E-3 AWACS and USN and USAF fighters escorting USN and USAF strike aircraft.

STOW-E was the first opportunity to exercise Air SF in an operationally relevant training environment. Lessons learned specific to the use of Air SF in STOW-E which were used to prepare for Kernel Blitz included:

- The requirement for simulating each aircraft type assigned to a carrier airwing and ARG, and the adversary aircraft employed by the Kernel Blitz classified threat,
- The requirement for use of valid guided weapon flyouts by SF entities,
- The capability to generate the number of validly behaving entities required to support a Fleet training exercise using fewer operators and hardware than current Navy CGF systems, and
- The capability for a SF operator to generate sorties in real time without freezing or resetting the simulation in response to immediate/unplanned tasking.

Kernel Blitz

The purpose of the USN/USMC Kernel Blitz exercise was to conduct predeployment qualification training for an Amphibious Ready Group (ARG). Normally, an ARG will be supported by a carrier battle group during such an exercise; however, no carriers were available for Kernel Blitz. In order to provide the ARG commander with a realistic tactical training environment which included carrier battle group assets, Air SF systems were used to generate Blue air sorties for a simulated carrier battle group and Orange air sorties of the adversary force. Air SF entity state data were translated into tactical data link (Link 11/TADIL A) messages which were then transmitted normally to the live Fleet participants operating off the coast of southern California. The resulting air sorties generated by Air SF appeared as tactical datalink tracks to the participants in the exercise on their tactical displays.

363 Blue and 142 Orange air sorties were generated using Air SF during Kernel Blitz. Blue sorties flown were tasked through the Integrated Tasking Order published around midnight, 4 hours before operations for a given day commenced and were generated at the Pacific Fleet Combat Training Center, Pt. Loma, CA. Orange air sorties were generated at the WISSARD facility according to a schedule of events published prior to the exercise. As during STOW-E, the sortie completion rate for Air SF for Kernel Blitz was 100%.

Kernel Blitz "firsts"[5] included:

- First DIS training exercise with the target training audience at the Flag/Staff level,
- First DIS exercise integrated with live C^4I,
- First use of Red Defense Simulation Internet Wide Area Network for a training exercise,
- First distributed generation and control of adversary forces for a training exercise, and
- First DIS exercise primarily driven by CGF.

The potential for DIS technology including Air SF to support USN training which was observed in STOW-E was realized in Kernel Blitz. Air SF significantly enhanced training at each level from the console operator who identified and classified tracks to the Fleet Officer in Tactical Command. The quality of entity behavior provided through Air SF was the key reason for this success.

SUMMARY

Service SF systems designed to support training exercises up to the JTF level are currently in development under ARPA sponsorship. ARPA SF projects include entity system and behavior development, Command Entity development, and command and control communications development for the USA, USN, USMC and USAF. These SF systems will be used to support USACOM JTF training for STOW '97 and subsequent exercises.

The result of the ARPA SF development program will be CGF systems which validly represent complex behaviors at an entity level and are capable of generating a sufficient number of entities to replace aggregation model systems. STOW '97 will demonstrate this potential. SF systems will be used in a similar manner as wargames are today for JTF command level training with the additional capability for commanders to observe combat interactions at an entity level of resolution, if desired. These SF systems are also designed to support doctrine development and test and evaluation exercises which may require use of higher fidelity entity system and behavior models than are required for training purposes.

Air SF is a development effort within the ARPA SF development program to create air entities for use by each service SF project. Air SF is based on the success of the ModSAF development effort and has been used in support of two major training exercises, STOW-E and Kernel Blitz, with 100% success. Lessons learned from these exercises and gained during the continuing development of Air SF will be applied to enhance the capability of Air SF for STOW '97.

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