First Applications of the Joint Forces Command Information Operations Range- An ACETEF Perspective

Stephen C. O'Day, Ph.D. (Stephen.O'Day@navy.mil)
Kirk J. Bonnevier (Kirk.Bonnevier@navy.mil)
Derek L. Kropp (Derek.Kropp@navy.mil)
Michael R. Morrison (Michael.Morrison@navy.mil)
NAVAIR Integrated Battlespace Simulation and Test (IBST) Dept.
Department of the Navy
Commander
ACETEF 54200A Bldg 2109
48150 Shaw Road Unit 5
Patuxent River, MD 20670-1907
Telephone :(301) 342-6000
Fax :(301) 342-6381

Mark R. Freed (Mark.Freed@navy.mil)
Eagan, McAllister, Associates, Incorporated
P.O. Box 986
Lexington Park, MD 20653
Telephone :(301) 342-6351
Fax :(301) 342-6381

Abstract

The Air Combat Environment Test and Evaluation Facility (ACETEF), located at Patuxent River, MD, participated in the Navy Use Case (NUC) event sponsored by Joint Forces Command (JFCOM). Some of the other sites participating in this distributed simulation event included the Integrated Battlespace Arena (IBAR) at China Lake, CA, the Joint Research Analysis and Assessment Center (JRAAC) at Huntsville, AL and facilities located at Ft. Meade, MD. The Information Operations Range(IOR) network is designed to support testing of effects-based operations techniques and tools. This paper will describe the goals of the NUC event, the first implementation of the IOR, and how the hardware and software assets at ACETEF supported this event. Among the ACETEF assets involved in the NUC were the Joint Integrated Mission Model ACE (JIMMACE), the JIMMACE-JRAAC High Level Architecture (HLA) interface, Tactical Plot (TacPlot) and the I-32 radar stimulator. These tools are installed in the newly completed Advanced System Integration Laboratory (ASIL). The software and hardware integration for the NUC event leveraged heavily on a portion of the JFCOM Terminal Fury 06 Information Operations Insertion (TF06IOI) for the Pacific Command. A discussion of the TF06IOI legacy, and the evolution of this work into the NUC, is included in the paper as well.

Report Documentation Page

1. REPORT DATE **2006**	2. REPORT TYPE	3. DATES COVERED **00-00-2006 to 00-00-2006**

4. TITLE AND SUBTITLE	
First Applications of the Joint Forces Command Information Operations Range- An ACETEF Perspective	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)	
	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **NAVAIR,Integrated Battlespace Simulation and Test (IBST) Dept.,48150 Shaw Road Unit 5,Patuxent River,MD,20670-1907**	8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
2006 ITEA Modeling and Simulation Conference, Dec 11-14, 2006, Las Cruces, NM

14. ABSTRACT
The Air Combat Environment Test and Evaluation Facility (ACETEF), located at Patuxent River, MD, participated in the Navy Use Case (NUC) event sponsored by Joint Forces Command (JFCOM). Some of the other sites participating in this distributed simulation event included the Integrated Battlespace Arena (IBAR) at China Lake, CA, the Joint Research Analysis and Assessment Center (JRAAC) at Huntsville, AL and facilities located at Ft. Meade, MD. The Information Operations Range(IOR) network is designed to support testing of effects-based operations techniques and tools. This paper will describe the goals of the NUC event, the first implementation of the IOR, and how the hardware and software assets at ACETEF supported this event. Among the ACETEF assets involved in the NUC were the Joint Integrated Mission Model ACE (JIMMACE), the JIMMACE-JRAAC High Level Architecture (HLA) interface, Tactical Plot (TacPlot) and the I-32 radar stimulator. These tools are installed in the newly completed Advanced System Integration Laboratory (ASIL). The software and hardware integration for the NUC event leveraged heavily on a portion of the JFCOM Terminal Fury 06 Information Operations Insertion (TF06IOI) for the Pacific Command. A discussion of the TF06IOI legacy, and the evolution of this work into the NUC, is included in the paper as well.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**12**	

Introduction

In 2005, Joint Forces Command[1] proposed the construction of the IOR to provide a secure, persistent network environment to test software and hardware-based information operations tools. In 2006, a functioning IOR was completed. The first two applications of the IOR were the Navy Use Case (NUC) and the Army Use Case (AUC). Each event was designed to demonstrate the future utility of this capability. This paper will focus on the features of the network and ACETEF's contribution to the NUC.

Figure 1. Navy Use Case participating sites.

Background

The forerunner of the NUC was the JFCOM TF06IOI for the Pacific Command. The software and hardware tools developed for TF06IOI were directly applied to NUC. Figure 1 shows the sites involved in TF06IOI. China Lake Integrated Battlespace Arena (IBAR), China Lake Electronic Combat Range (ECR), JRAAC and ACETEF all participated in TF06IOI using the Defense Research Engineering Network(DREN) network.
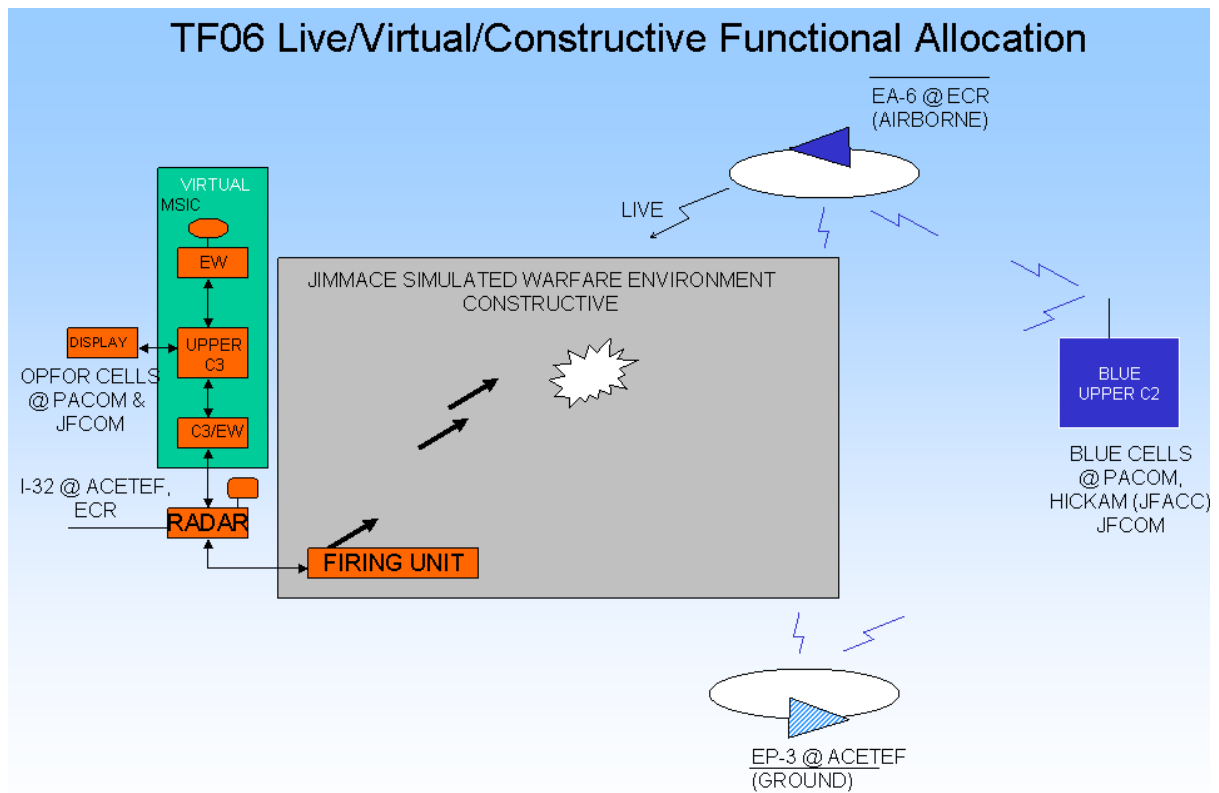
Figure 2. TF06IOI functional allocation of scenario.

Figure 2 shows a top-level view of the TF06IOI scenario and data flow. In TF06IOI, live ECR aircraft kinematics were passed locally to IBAR, reformatted and then forwarded to ACETEF via a User Datagram Protocol (UDP) socket connection. The ECR aircraft kinematics data were inserted into the JIMMACE simulated warfare environment [2], [3] by way of a ScramNet™ reflected shared memory interface.

Note that although the live data was passed from the ECR, the JIMMACE constructive environment is not restricted to using this range as a gaming area. The Generic Position Velocity Orientation(GPVO) package was used to transform the aircraft kinematics into the TF06IOI gaming area which was an entirely different geographic region. Live aircraft data can thus be translated and rotated to a different part of the world while the relative orientation, velocity and position of the aircraft is preserved with respect to the I-32. Other virtual and constructive entities may then be introduced into this simulated warfare environment via JIMMACE databases or by the additional JIMMACE shared memory interfaces which will now be described.

A second JIMMACE shared memory interface provided the I-32[4] with the simulation environment data necessary for the stimulation of an aircraft on the ground and the I-32

returned platform entity information to JIMMACE. A third JIMMACE shared memory interface communicated with JRAAC using the High Level Architecture (HLA) JRAAC Federation Object Model (FOM). JRAAC published threat data to the JIMMACE shared memory interface and subscribed to JIMMACE blue target data. JRAAC communicated with the China Lake I-32 federate using this HLA federation as well.

Figure 3 shows the DREN network connectivity between the sites. The ECR was connected to IBAR with data STEs. A DREN connection existed between IBAR, MSIC and ACETEF. The EP-3 was able to communicate with JTF, PACOM, JFACC and JFCOM.
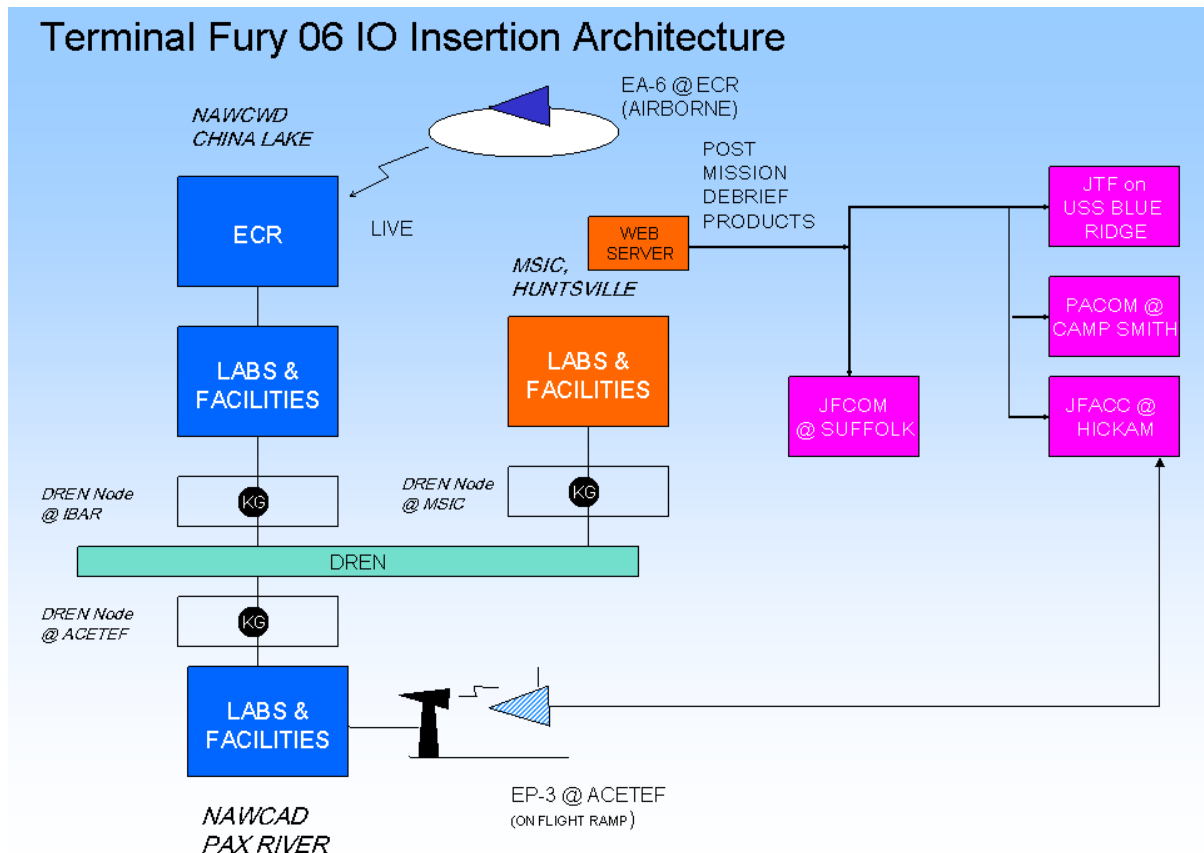

Figure 3. TF06IOI network architecture.

The two ACETEF laboratories and the flight ramp dedicated to TF06IOI are shown in figure 4. The Threat Air Defense Laboratory(TADL) contained ground threat software and electronics. The JIMMACE simulation laboratory contained computer resources for running the JIMMACE interfaces already described and collecting event data. The EP-3 resided on a flight ramp accessible to the TADL laboratory so that it could receive electronic stimulation.

Figure 4 TF06IOI ACETEF laboratories.

In the NUC architecture shown in figure 5, the same software connectivity infrastructure from TF06IOI was re-used and the Fort Meade site was added. The DREN connectivity was replaced with the IOR network. Each of the participating IOR sites created an isolated local area network (LAN), which could be attached to a service delivery point (SDP). Each SDP was setup by IOR network engineers at their respective sites. These SDPs were all connected to the Network Operations and Security Center (NOSC) of the IOR network located in Suffolk, VA.
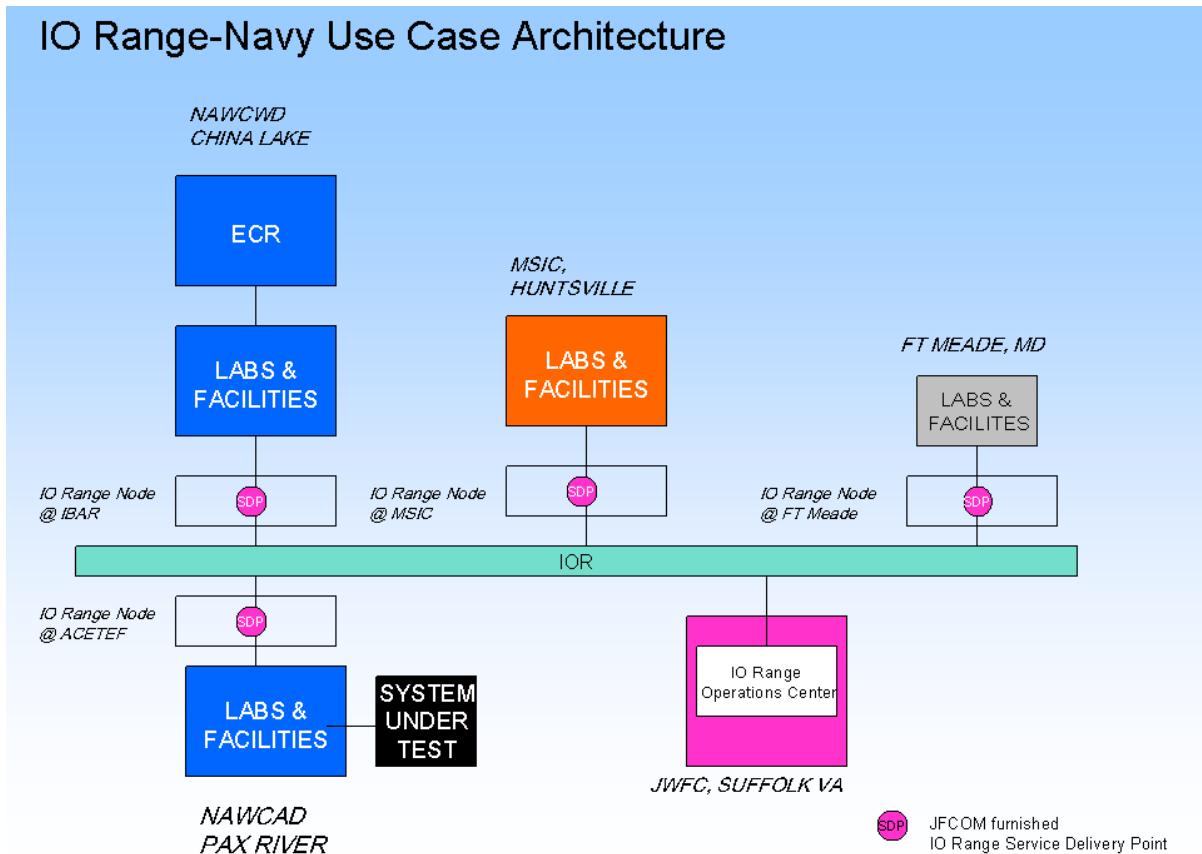
Figure 5. IOR network architecture

NUC Warfare Environment

A new JIMMACE simulated warfare environment was developed and implemented for this exercise. The emphasis of the NUC is the testing of information operations assets. The NUC network provides an environment for the effective testing of capabilities that can be fielded or simulated on a computer network. JIMMACE supports this by providing an environment which fills in the gaps with parametrically defined entities in place of live or virtual assets where needed.

The JIMMACE model illustrated in figure 6 provided a central point of situational awareness for both the TF06IOI and the NUC. The JIMMACE shared memory architecture makes it ideal for integrating multiple hardware and software assets. Each platform and system is modeled parametrically in a "type" database (TDB), instantiated in a "scenario" database (SDB) and mapped to a specific asset in the Configuration Data Base (CDB). Digital Terrain Elevation Data(DTED) databases can be used by JIMMACE to do line of sight and crash calculations.

JIMMACE defines groups of physical entities which systemically work together as players. Players are composed of platforms which exist at a particular location. Multiple systems may be attached to a particular platform. Systems in JIMMACE represent particular functionalities such as thinking, movement, sensing, launching of ordnance, jamming and communications. The role, mission and function of any player, platform or system in JIMMACE can be turned over to external control. Under internal control, JIMMACE players execute tactics and contingency plans. Externally controlled players can interact with JIMMACE players [5] in the simulated warfare environment and can cause variations in the behavior of constructive players. Many of these capabilities were exercised in NUC.
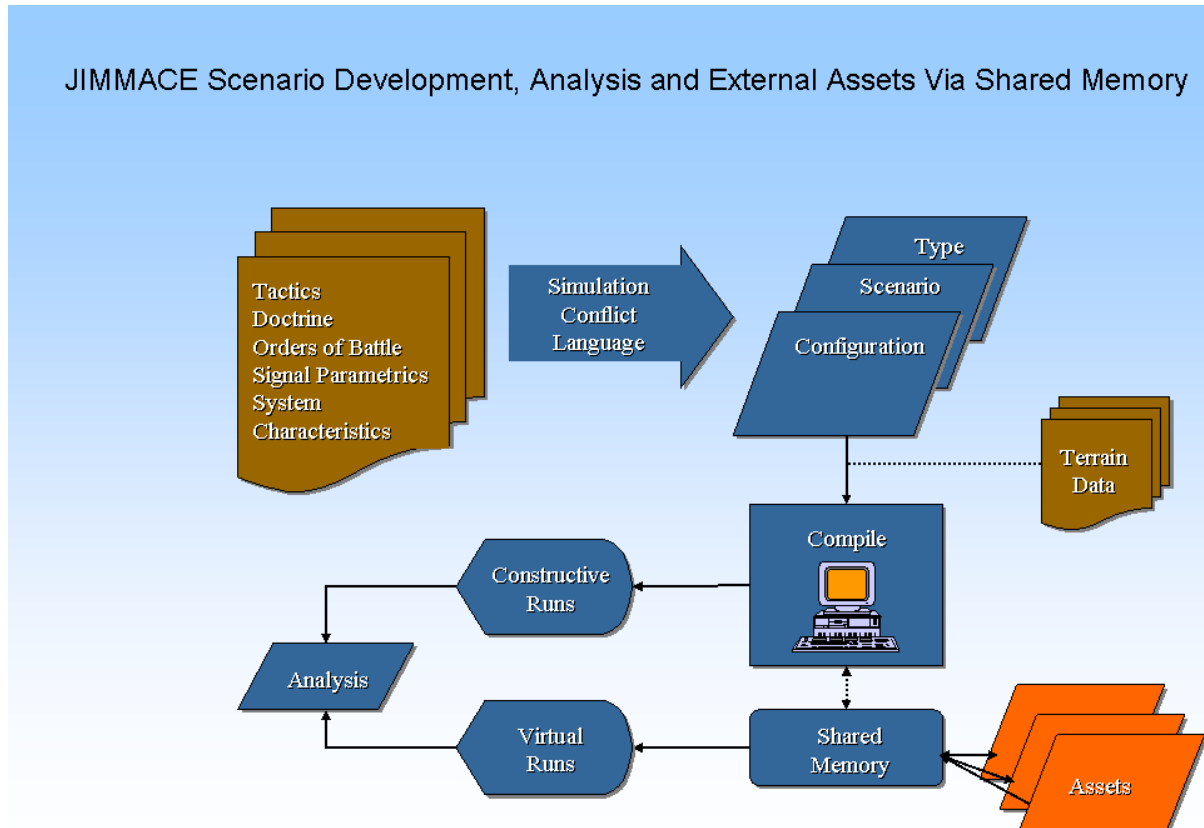

Figure 6. JIMMACE model application cycle.

In figure 7, a notional NUC scenario is shown in which a blue aircraft communications network was modeled along with the individual entities. A red ground threat was modeled to engage the blue side. Tactics were developed to break the blue aircraft from their orbits based on external triggering and to initiate engagements. In the next section, important visualization techniques of these tactics will be discussed.
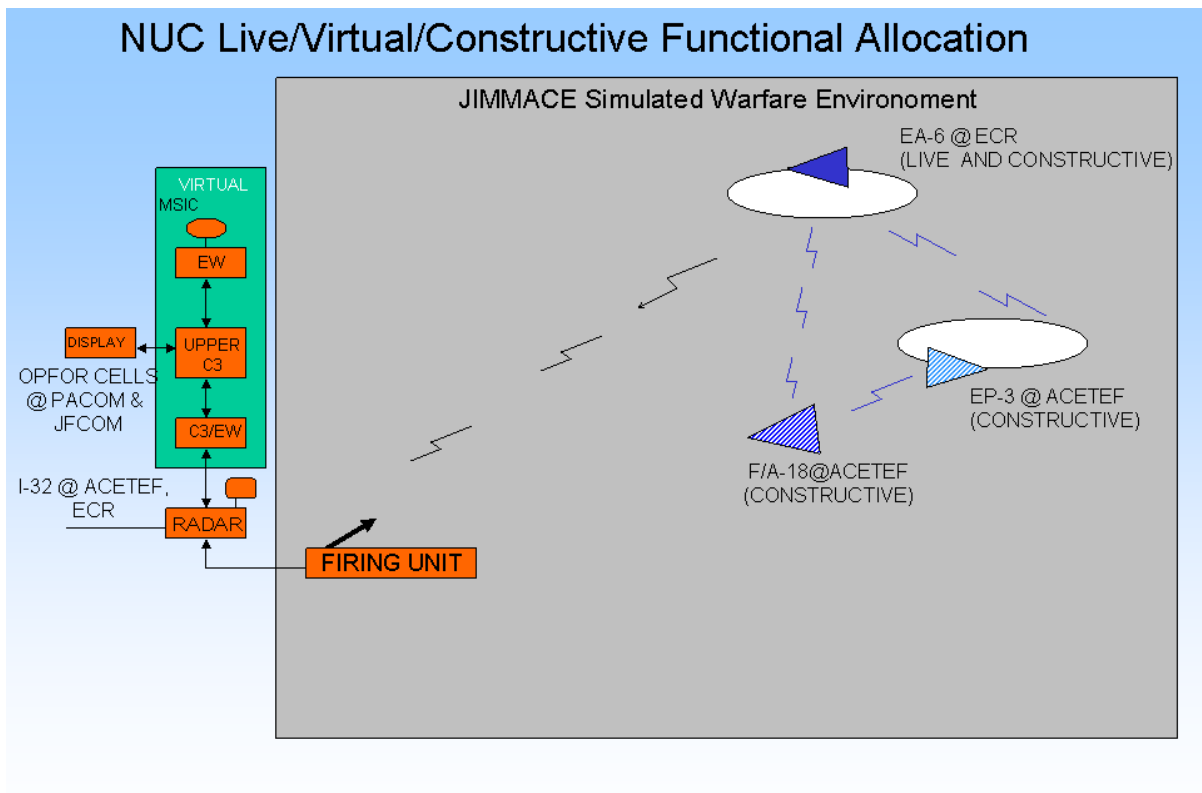
Figure 7. NUC functional allocation of assets.

NUC Visualization and Control

Each site performed system visualization differently. ACETEF visualizes the JIMMACE simulated warfare environment using TacPlot. This application ran locally on an ACETEF High Performance Computing (HPC) computer. As an asset to JIMMACE shared memory, TacPlot can do more than just passively present the environment. It can communicate directly with the JIMMACE model or other assets in the form of "user defined messages", create player entities, start other assets and initiate tactics.

TacPlot was the key to providing the JIMMACE operator a way to connect the electronic stimulation portion of the NUC event with the distributed software simulation portion. The control features present in JIMMACE were crucial to synchronizing the live, virtual and constructive portions of the NUC event. The JIMMACE operator could hear what was going on at other sites and stimulate certain constructive player communications tactics by injecting a message with TacPlot. As well, instantiating new constructive players with TacPlot stimulated the maneuver and engagement tactics of other constructive players.

Our plan was to have each site login to an ACETEF HPC asset over the IOR network and to remotely launch a copy of TacPlot. Each site would then have a visual representation of the constructive battlespace. Preliminary tests between Huntsville and the NOSC with another

graphics tool showed that remote graphics were possible. It is hoped that future events will more fully utilize this capability.

The principal features of TacPlot are illustrated in figure 8. Figures 9 and 10 provide more technical detail.
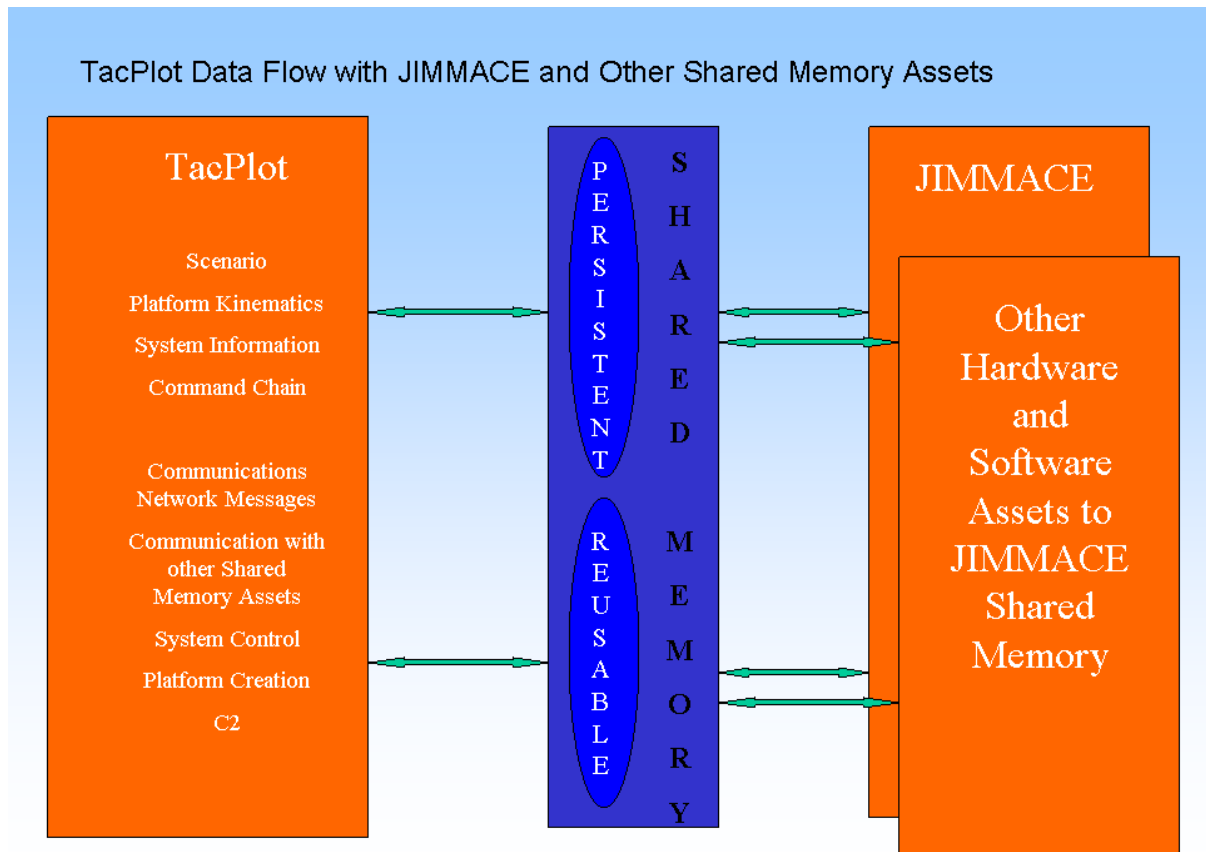

Figure 8. TacPlot data flow via shared memory.

From figure 9, one can see that TacPlot software can display terrain as well as physical entities. It can graphically display a summary of the kinematics and identification information for each physical entity. Communications is represented in TacPlot with lines such as the one shown between the EP-3 and the EA-6B. Individual platforms may be "hooked" or selected with the mouse and targeted communications may then be selected and sent via menu control. The arrow features on TacPlot permit the user to zoom in, pan around and do text labeling of particular entities using other buttons on the page.
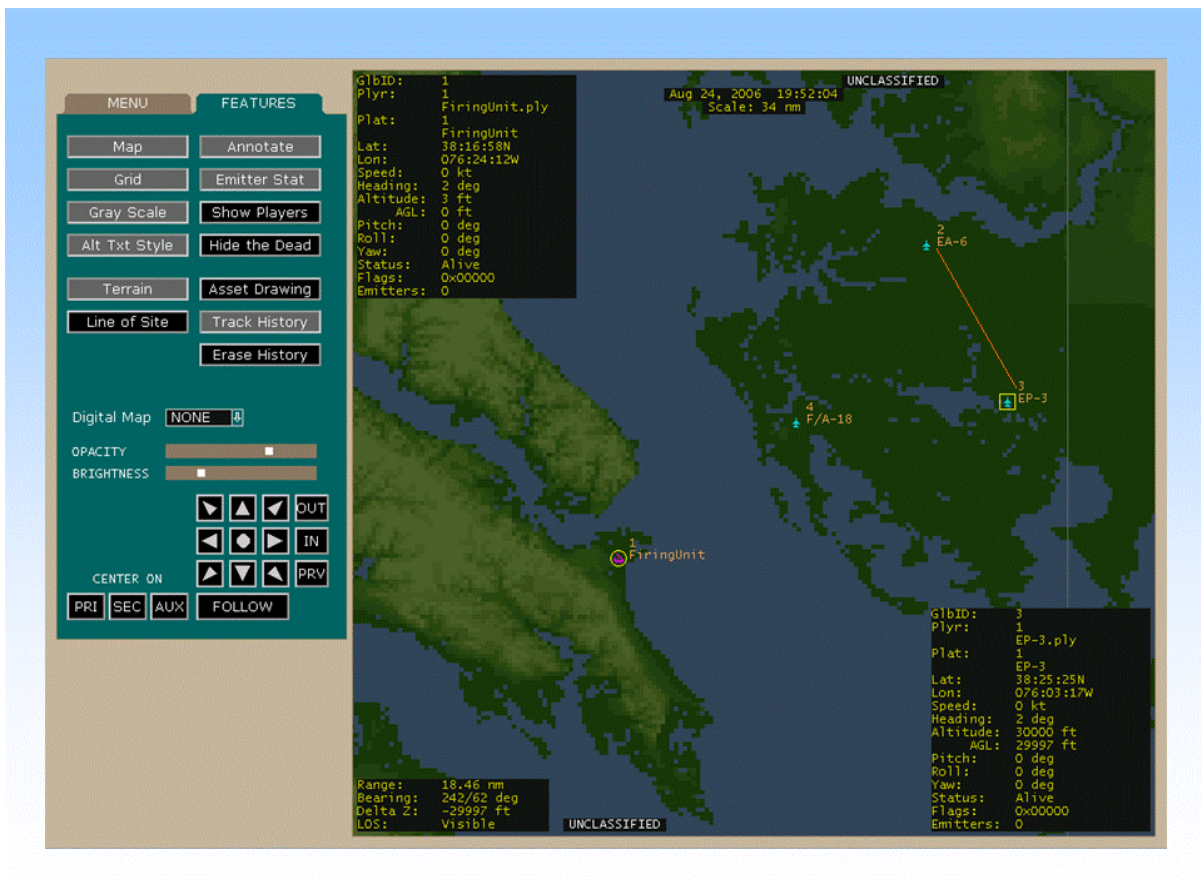
Figure 9. TacPlot "features" menu.

In figure 10, the "created player" sub-level focuses on the creation of new player entities. By right-clicking on a location and choosing a player "type", a new player may be created. Specific location, heading and speed may be typed into the menu as well. The platform identification information is present in the upper left hand corner of each menu level.

There are too many toolbar menu levels to show them all effectively, so some of the more important features will be described. Options exist in the top-level "menu" to overlay Oilstock maps and Department of Defense terrain data. A Maryland terrain example is shown with some of the NUC platform entities displayed. The "command chain" toolbar button will show player position within the Command and Control(C2) structure. The E/W control menu provides the user with an opportunity to control the emitter and weapon systems in JIMMACE. The "scenario" menu displays the location of the center of the gaming area and time information.
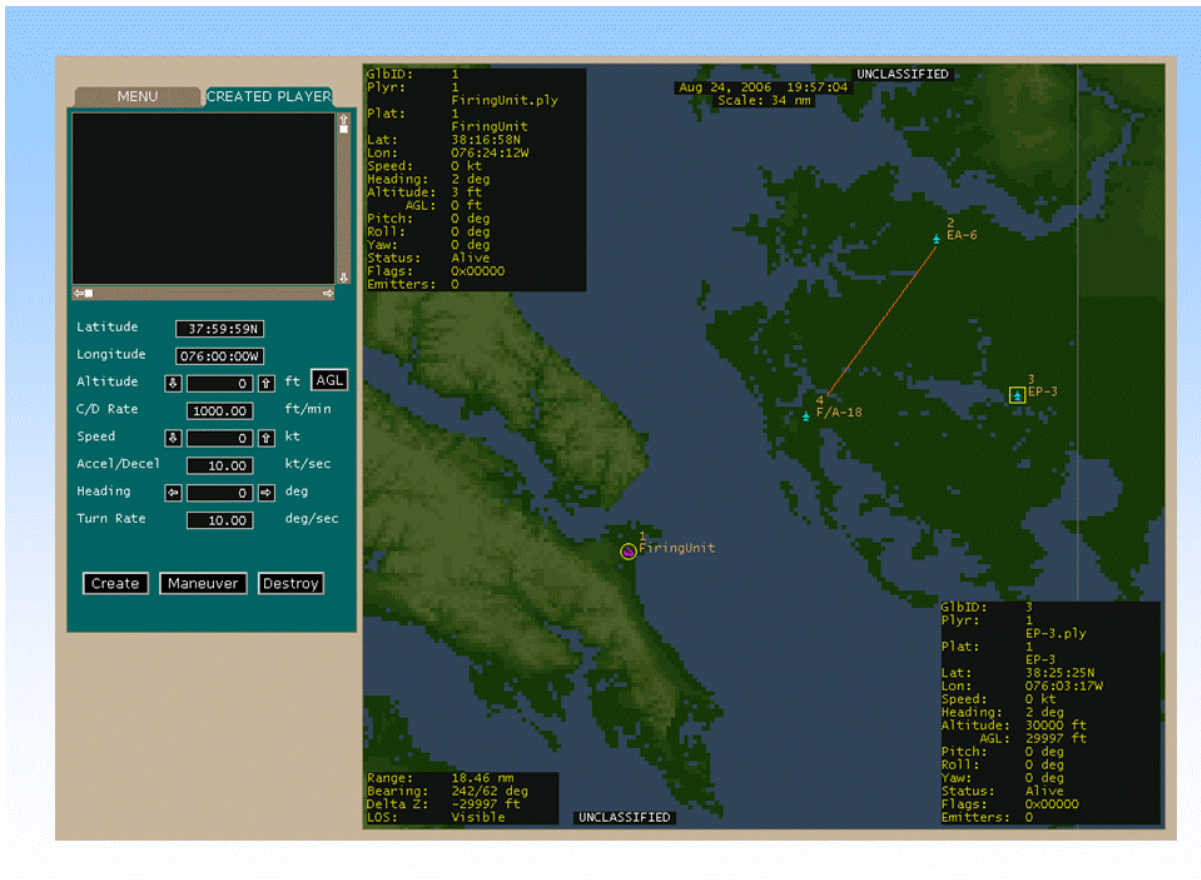
Figure 10. TacPlot created player menu.

Conclusions

The TF06IOI provided software tools and distributed connectivity experience which was leveraged to stand up the NUC. The NUC was the first test of the IOR network and its success in testing information operations assets bodes well for the future. The network was used again in the AUC and will again be used in the VJSEAD program to provide information operations test and evaluation for the benefit of the combatant commander as well as training for the warfighter.

Acknowledgements

success of the event. Process and planning support was provided by Roberto Rodriguez and Marcia Flatau from the Booz Allen team. We are also grateful for the support and confidence of CDR William "Huggie" Dodge at OPNAV N3IO as we worked to overcome various obstacles and challenges. Our NUC team members at China Lake, ECR, Fort Meade and the Missile Space and Intelligence Agency worked long hours with us to support this effort and have our gratitude as well. Finally, we thank Leroy Mrozowski, Chris Yagmin, Ray Solt, Rick Lang, Duane Salzman, Steve Coerber and Aaron Svendgaard for their special contributions at ACETEF which helped make this effort a success.

References

[1]http://www.jfcom.mil/
[2] R. Gibson, "The Perception-Reaction Simulation Model for Enterprise Control Systems", Proceedings of the Tenth Annual International Symposium of the International Council on Systems Engineering July 16 - 20, 2000, pp. 221.
[3] R. Gibson and M. Chapman, "Legacy Software Testing - A Current Methodology, " Proceedings of the Eleventh Annual International Symposium of the International Council on Systems Engineering July 1 - 5, 2001.
[4]http://www.ewa.com/
[5] J. McMaster, S. O'Day, J. Sarratt, "Millennium Challenge 2002 Fleet Battle Experiment Juliet Analytical Excursions with JIMMACE", Proceedings of the ITEA Modeling and Simulation Conference, Las Cruces, NM, December 2003.