**2004 Command and Control Research and Technology Symposium
The Power of Information Age Concepts and Technologies**

An Environment for Comparing Command and Control Architectures

Dr. John James and MAJ Fernando Maymi

**Corresponding Auuthor: John James
Department of Electrical Engineering and Computer Science, USMA
Thayer Hall, Building 601, Room 1107
West Point, NY 10996
Phone: 845 938-5563
FAX: 845 938-5956
John-James@usma.edu**

Abstract:

As with current operations, future Joint Operations will require availability a range of direct-fire and indirect-fire (non-line-of-sight) weapons to engage enemy targets. One such weapon system being considered is the non-line-of-sight Launch System (NLOS-LS) with associated indirect-fire missiles: the Precision Attack Missile (PAM) and Loitering Attack Missile (LAM)[1]. The NLOS-LS set of systems is expected to be a key component of a suite of indirect fire weapons available to future commanders [2].

An active area of review, analysis and research has been in the consideration of the impact of the ongoing revolution in information systems to command and control systems [3, 4, 5, 6]. The notion that “information age” warfare is in some sense “network centric” implies a capability to dynamically “understand” the state of the battlespace (information dominance) and dynamically alter plans based on that understanding (i.e. “get inside the decision cycle” of opposing force commanders).

Fundamental to these considerations for future command and control systems is the issue of system architecture comparison and selection. This paper will provide an overview of an architecture comparison environment being implemented for an undergraduate project in control system architecture comparison. There have been many efforts in software architecture comparison over the past ten years [7, 8, 9]. The cadet work will focus on design and implementation of airspace deconfliction algorithms. For that area, they will compare three different missile control architectures: centralized control, semiautonomous control, and autonomous control. They will also "brainstorm" Information Assurance (IA) issues. In order for the cadet deconfliction work to be done, the missiles, targets, and obstacles have to be identified and the simulation dynamics provided.

This semester the cadet team will produce a Software Requirement Specification (SRS) and a Software Design Document (SDD) while their software implementation will be done next semester. Thus, the software environment for the cadet work is being set up now for use next semester. Currently, faculty requests have resulted in availability of the OTB (OneSAF Testbed Baseline) as modified by the U. S. Army Communications Electronics Command (CECOM) under a Defense Advanced Research Projects Agency (DARPA) project. The DARPA project has resulted in the capability to control simulated Future Combat System (FCS) unmanned ground vehicles. Faculty will modify the CECOM interface for ground vehicles to enable providing the data needed by the cadet project. However, the dynamics for the targets, obstacles, and missiles will also have to be added. The plan is to have faculty modify a solution available from the Mathworks that implements some prior work in controlling a swarm of missiles to engage a set of targets, <http://www.mathworks.com/company/digest/may03/modeling.shtml>.

In addition, we expect the simulation environment to support faculty research into other areas of interest. Concerning possible faculty/other research issues, it should be noted that the OneSAF software is expected to provide event-based simulations of operational scenarios and the Matlab/Simulink software is expected to provide continuous time and space simulations as well as the link between event-based and continuous simulations. A

rich environment of the system state will thus be available. In this environment, the only invariant is expected to be the *commander's intent* with all other system parameters being subject to change during the duration of the simulation. The set of issues associated with NLOS-LS networked communications (such as QoS, bandwidth allocation, trustworthiness of system state parameters, ...) is an area of research that is essentially open-ended. Another area that has been investigated for many years without resolution is the fusion of network sensor data (such as target identification, target update, obstacle identification, obstacle update, ...).

REFERENCES:

1. An overview of the NLOS-LS is found in the Army RDT&E Budget Item Justification,
<http://www.dtic.mil/descriptivesum/Y2004/Army/0604645A.pdf> .
2. A visualization of the NLOS-LS operational concept
<http://www.gordon.army.mil/symposium/2002/2002pri/briefings/DCD-TSM/JTRS/FA%20Briefing.pdf>
3. [Network-Centric Warfare: Its Origin and Future.](#), Vice Admiral Arthur K. Cebrowski, U.S. Navy, and John J. Garstka, JCS J-6, January 1998.
4. [Network Centric Warfare Report to Congress.](#), July 2001
5. [Understanding Information Age Warfare](#), Davis S. Alberts, John J. Gartska, Richard E. Hayes, and David A. Signori, ISBN: 1-893723-04-06, 2001
6. [Network Centric Warfare](#), Davis S. Alberts, John J. Gartska, and Frederick P. Stein, 2nd edition, ISBN: 1-57906-019-6, 2000.
7. James, J. R. and R. McClain, "[Tools and Techniques for Evaluating Control Architectures](#)", proceedings of the 1999 IEEE Conference on Computer-Aided Control System Design, Kohala, Hawaii, August 1999.
8. Medvidovic, Nenad and Richard N. Taylor "[A Classification and Comparison Framework for Software Architecture Description Languages](#)"
9. Mary Shaw and David Garlan "[Tutorial Slides on Software Architecture](#)" August 1997.