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Hostile Fire Defeat ATO: A Quick Look at C&C and Resource Cueing

by Jesse B. Kovach and Christopher H. Winslow

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14. ABSTRACT A summary of the experimental Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) system used at the 2010 Capstone Experiment for the Hostile Fire Defeat Army Technology Objective (HFD ATO) is presented. The overview includes discussion of the Common Operating Picture (COP), the use of Cursor on Target (CoT) as an interoperability vehicle, and the presentation of a new and novel resource cueing system that makes use of SQLite to store potential target information and Blue Force asset information. Resource Cueing policies are represented as SQL triggers stored in the database schema.						
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1. Introduction

The Battlefield Information Processing Branch brought three technologies/capabilities to the Hostile Fire Defeat Army Technology Objective's (HFD ATO) Capstone Experiment. The three technologies/capabilities are:

- Common Operating Picture (COP) that allows for the display of relevant information on a single display system and allows for collaboration between multiple levels of command.
- An interface that allows access to/from the branch's Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) software via Cursor on Target messages.
- A resource cueing application that is controlled by SQL-like rule structures.

2. Common Operating Picture

The COP used at the CE consisted of two user-level applications that were supported by a series of U.S. Army Research Laboratory (ARL)-developed experimental data stores and inter-process communications schemes. The first of the two user-level applications was a mapping application known as SharedInk. SharedInk is based on the Commercial Joint Mapping Tool Kit (CJMTK) and uses MIL-STD-2525 symbols to display geo-referenced information about sensor position and sensor detections. This displayed symbol information is enhanced by adding the ability to display sensor characteristics such as field of view, graphical representation of Line of Bearing Reports (LOBR), and an indication as to whether imagery is available at a particular location. The second user-level application is known as the ARL Asset Annotator. This application allows a user to view and annotate still and video images from any system that is connected to the C4ISR network. This connection can be made using ARL-specific communications schemes or via standard Cursor on Target (CoT) interfaces.

Figure 1 shows an example of the map display. On this display, the locations of the sensors are shown using the blue MIL-STD-2525 sensor symbols. The pie-shaped figures emanating out from some of the sensors show the field of view of each of those sensors. The red lines radiating out from some of the sensors indicate that a LOBR has been generated by that sensor. Towards the middle of the figure, there are two yellow MIL-STD-2525 "unknown unit" symbols. Note that these symbols are near the intersection of several LOBRs. These symbols represent the computed location of a source of gunfire.

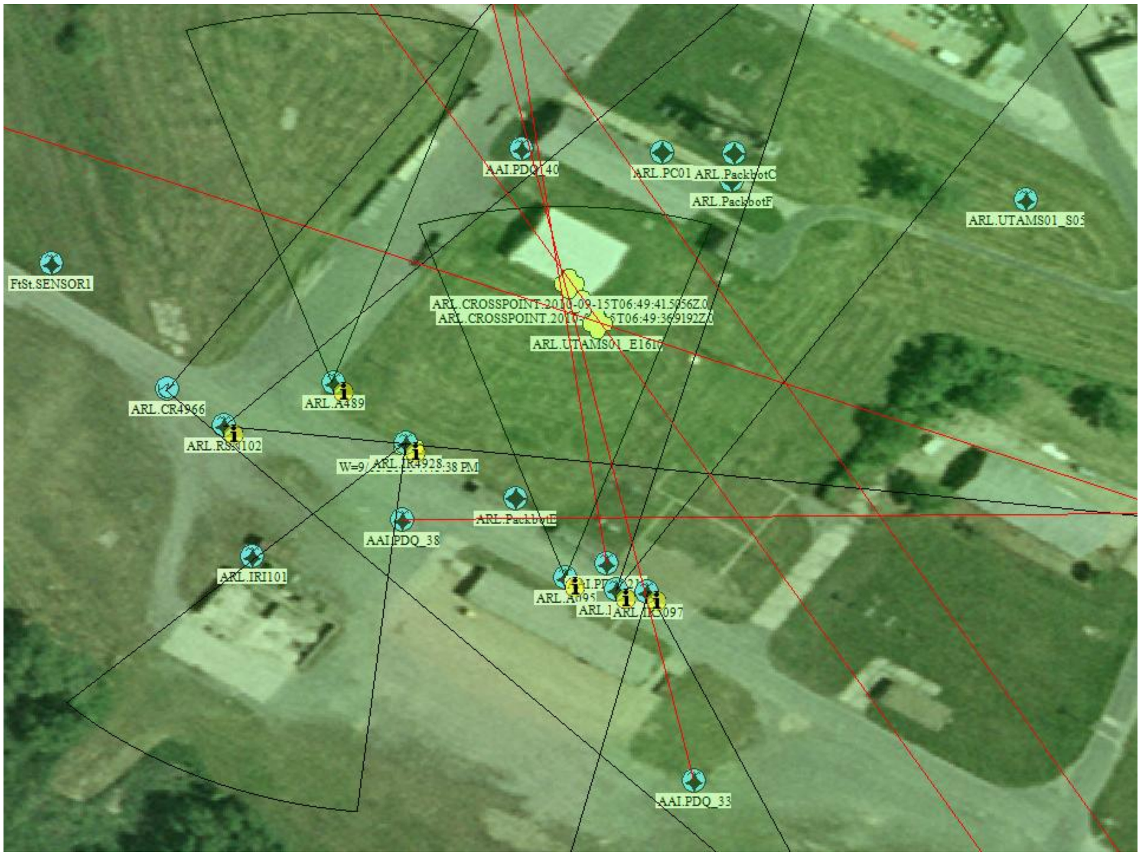

Figure 1. COP map display.

Figure 2 shows a typical view of the ARL Asset Annotator. Across the top are tabs for each of the individual sensors that have reported imagery. On the left are thumbnails of images from a particular sensor. On the right is a large view of a single image. As can be seen, this image has been annotated with both pen and text.

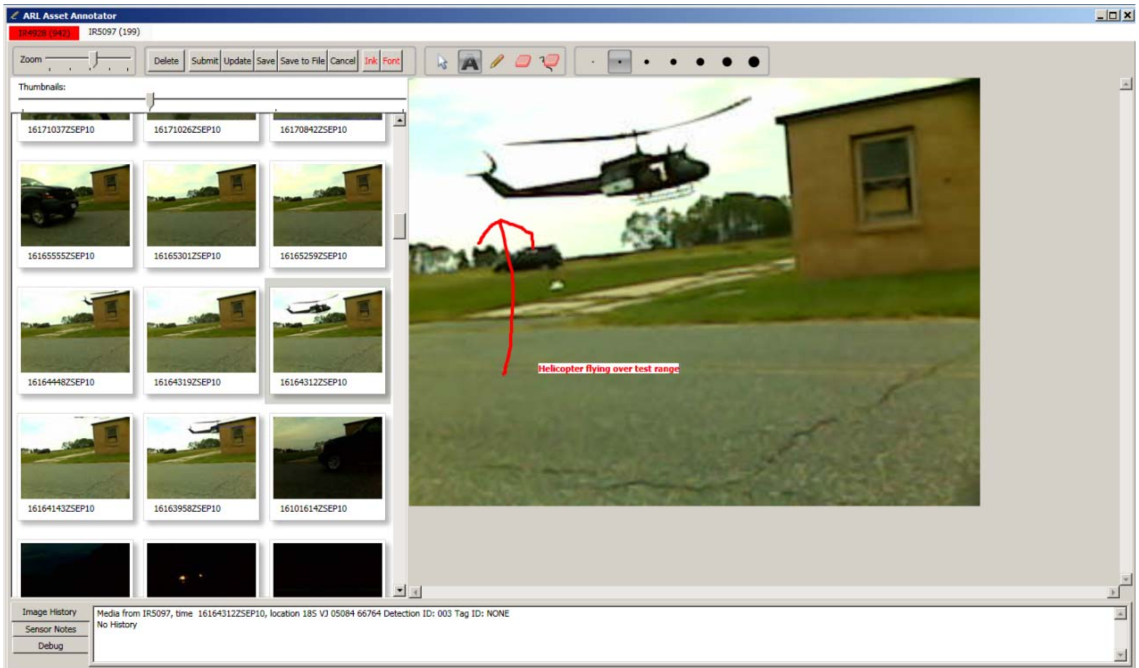

Figure 2. COP asset annotator.

3. Cursor on Target

CoT is an XML-based data structure that is suitable for the transfer of track information, imagery information, Intelligence, Surveillance, & Reconnaissance (ISR) tasking, and a variety of other information types that are useful in C4ISR systems. The core schema has been registered in the Department of Defense (DoD) XML Registry since 2003. An advantage of CoT is that the development of sub-schemas is encouraged, as there is a methodology to segregate experimental sub-schemas into specific portions of a CoT message. The Battlefield Information Processing Branch has developed some sub-schemas that are directly related to the transfer of LOBR information. The branch is currently investigating the feasibility of proposing formal changes to the CoT schema. Beside the fact that CoT has technical merit, it offers the advantage that it is reasonably well-documented, supported by over 100 systems, and is not tied to any particular system—that is, a vendor who claims to support CoT claims to support some level of interoperability between systems and vendors.

Table 1 lists the systems that were integrated into the COP. Some of those systems integrated via ARL-developed communication mechanisms, and some of those systems integrated via the standard MITRE CoT server. All information was sent and received as CoT messages, regardless of the communication mechanism used. Each system is marked in table 1 with its integration mechanism.

Table 1. List of HFD sensors.

SYSTEM	INTEGRATION LEVEL	MFR
Ground based MAST acoustic sensor	ARL	ARL/AAI
Packbot based MAST acoustic sensor	ARL	ARL/AAI
Balloon based UTAMS acoustic sensor	ARL	ARL
Ground based UTAMS acoustic sensor	CoT	ARL
Ground based PDCue acoustic sensor	CoT	AAI
Ground based FightSight IR/acoustic sensor	CoT	ARA
Ground based Mobile Optical Detection Sys.	ARL	ARL
Ground based IR video sensor	ARL	ARL
Ground based IR trip wire camera	ARL	ARL
Ground based pan/tilt video camera	ARL	ARL
Balloon based pan/tilt video camera	ARL	ARL
Ground based Compact Radar	ARL	ARL

4. Resource Cueing

The resource cueing capability used at HFD has two main components. The first component is TripwireTracker, a simple application that receives LOBRs from a number of different ARL-developed and vendor-developed sensors, and computes averaged intersection points and quality scores using an iterative algorithm. TripwireTracker is a proof-of-concept demonstration of data fusion between sensors provided by multiple vendors and is not intended or presented as an advanced fusion algorithm.

The second component of the cuing system is AutocueServer, which receives raw LOBR reports, fused detections, and blue force tracking information from a variety of different CoT data sources, and generates asset cuing commands based on stored policies. AutocueServer uses a SQLite database to store sensor report and asset location information. Cuing policies are represented as SQL triggers stored in the database schema. User-defined functions written in C# can be called from the triggers to send commands to cameras, robots, and other assets. This approach allows for cuing policies to be defined and changed at runtime. Also, by using SQL to represent cuing policies, the system designer was not burdened with designing and implementing yet another custom policy language. Because the cuing system uses standard CoT interfaces and message formats to send and receive data, it is possible to use sensors with different characteristics and different modes of operation from different vendors in order to achieve a more complete solution for the defeat of hostile fire.

Several cuing policies and behaviors were demonstrated at the HFD experiment. The simplest behavior was to cue one camera with detections from Micro Autonomous System Technologies (MAST) acoustic sensors, while cuing another camera with detections from Unattended Transient Acoustic MASINT Sensor (UTAMS) sensors. A more complex behavior was to find the closest camera to a given detection and cue it towards the location of the detection, while leaving other cameras alone. (This behavior could easily be extended to take into account line-of-sight computations if such a capability is available.) Another behavior picked a single target from the compact radar and cued a camera to track that target as it moved, while ignoring all other targets generated by the compact radar. A final behavior used blue force tracking data to cue a camera to track a robot as the robot moved around the test range. Behaviors can also be defined to cue robots as well as cameras, and to cue different assets for detections occurring in predefined geographic regions, although these capabilities were not demonstrated at the HFD experiment.

List of Symbols, Abbreviations, and Acronyms

ARL	U.S. Army Research Laboratory
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
COP	Common Operating Picture
CoT	Cursor on Target
CJMTK	Commercial Joint Mapping Tool Kit
DoD	Department of Defense
HFD ATO	Hostile Fire Defeat Army Technology Objective
ISR	Intelligence, Surveillance, & Reconnaissance
LOBR	Line of Bearing Reports
MAST	Micro Autonomous System Technologies
MASINT	Measurement & Signal Intelligence
UTAMS	Unattended Transient Acoustic MASINT Sensor

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