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**Exercise Control Objects (ECOs),
C2 for the Control Team**

C2 Modeling and Simulation
Cognitive Domain Issues
Social Domain Issues

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ABSTRACT

The U. S. Joint Forces Command (USJFCOM), J9 Modeling and Simulation (M&S) Support Team advanced the capability of distributed simulation in support of Urban Resolve 05 (UR05), a collaborative effort conducted by USJFCOM and the Institute for Defense Analyses (IDA). Using real-world data, the scenarios in UR05 realistically replicated current operations and situations faced by warfighters in Baghdad. The team designed and employed Exercise Control Object (ECO) processes and tools for use in this distributed simulation environment. The Simulation Control Team share their intentions and actions regarding activities of the adversaries, blue forces and civilian population using ECOs. The ECOs were shared instantly among controllers and were displayed on the terrain map as symbolic objects. ECOs contain the author's identification, location coordinates, time created/modified, ECO category, free-text comments, information to be disclosed to the players. The ECO editor let controllers attach graphics and text files to the object. These ECOs were logged to support real-time and post-experiment assessment. USJFCOM's success in using ECOs to enable the JUO series of experiments and the enthusiasm and innovation that controllers showed in using them, indicates this simple tool would be useful if implemented in other simulation systems and operational C2 systems.

ABOUT THE AUTHORS

Michael Anhalt is retired Navy Surface Line Commander with over 23 years of operational experience, including specialties in Amphibious Warfare, Surface, Undersea, and Strike Warfare, and tactical training. Thirteen years experience in planning and directing system-engineering efforts related to modeling & simulation and their integration with military command and control (C2) systems. He provides on-site technical support in planning for and conducting warfighting exercises and experiments, prototype development, and demonstration of advanced technologies for next generation C2 Systems and Command Centers. He holds a Master of Science degree in Educational Technology. Mr. Anhalt co-authored a paper selected for presentation at I/ITSEC 2005, "Developing Situation Awareness Metrics in a Synthetic Battlespace Environment", paper #2218.

Laura Dunleavy has worked in Modeling and Simulation for thirteen years, with the last several years spent in support of JFCOM-sponsored exercises, currently working on Urban Resolve. She is a Senior Software Engineer at Lockheed Martin Simulation Training and Support Advanced Simulation Center in Suffolk, VA. She received her Bachelor of Science in Applied Mathematics, with an emphasis in Computer Science, from Auburn University.

Experiment Control Objects (ECOs), C2 for the Control Team

Introduction

The U. S. Joint Forces Command (USJFCOM), J9 Modeling and Simulation (M&S) Support Team advanced the capability of distributed simulation in support of Urban Resolve 05 (UR05), a collaborative effort conducted by USJFCOM and the Institute for Defense Analyses (IDA). Using real-world data, the scenarios in UR05 realistically replicated current operations and situations faced by warfighters in Baghdad. The M&S team designed and employed Exercise Control Object (ECO) processes and tools for use in this distributed simulation environment. Joint Semi-Automated Forces (JSAF) simulation was the centerpiece of the simulation federation. JSAF is an entity-level simulation designed for Human-In-The-Loop (HITL) involvement of simulation controllers. JSAF runs in real-time and many of its entity maneuvers and behaviors are cued, or directed, by the sim controllers. This direct control of the simulation makes it a preferred simulation for conducting dynamic exercises where players direct their forces at the direction of the players.

For five months, two weeks each month, the simulation team controlled the events from USJFCOM in Suffolk VA, with support from team members located at the Army Topographic Engineering Center (TEC), Fort Belvoir, VA, and the Space and Naval Warfare Systems Center (SSC), San Diego, CA.

The team operated nearly 100 entity platforms and sensors, who's actions and activities were based on their in-theater (Baghdad) employment, including; cameras, flash detectors, seismic sensors and fire-finder radars. Sim controllers managed and provided camera feeds to the players using ModStealth, a 3d display.

Red Team members at TEC controlled insurgents, and members at USJFCOM controlled Blue Army units, other friendly forces, special agents, Iraqi troops and police.

M&S Team members at SPAWAR Systems Center (SSC), San Diego populated the urban environment with more than 120,000 civilian pedestrians and vehicles to portray daily activity and traffic, using the new 'JSAF Culture' Simulation.

A functional diagram of the USJFCOM/IDA exercise environment is shown below.



Figure 1 Urban Resolve Experiment Control Architecture

Experiment planners and simulation controllers use Exercise Control Objects (ECOs) to plan experiment events and control the conduct of experiments. Simulation controllers shared their intentions and actions regarding activities of the adversaries, blue forces and civilian population using ECOs.

ECOs are compact packages of information, created by sim controllers and symbolically displayed on the terrain map. They contain the author's identification, location coordinates, ECO number, time created (or modified), ECO category, free-text comments and disclosures, and provide the functionality to attach graphics and text files to the ECO object.

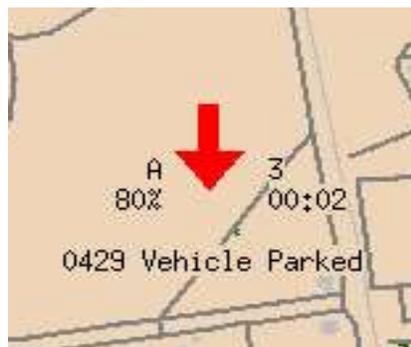


Figure 1 ECO Map Symbol Example

In JSAF, ECOs are either created using a JSAF Situational Awareness Editor, or by spreadsheet. The benefit of ECOs is that they are easy to create and modify to fit varied operational missions. They are shared instantly among controllers and are displayed on the terrain map as symbolic

objects. ECOs are logged to support real-time and post-experiment assessment. Data can be saved to spreadsheet, manipulated and then reloaded back into simulation.

The ECO Exercise Control Editor shown below is a design being implemented in JSAF that evolved from a prototype used in UR05. Its functionality evolved out of the experience gained in using the Situational Awareness Editor to create Situational Awareness Objects (SAOs) in the USJFCOM experiment environment. During the UR05 Current Operations experiment, ECOs existed as a type of Situational Awareness Object (SAO).

The ECO Editor will be tailored specifically for the exercise controllers, it eliminates SAO functions that are not relevant to ECOs and adds a free-text window to indicate disclosures to be made to experiment subjects, along with the conditions necessary for the disclosure to be made. The attach file feature lets planners pre-stage disclosure documents, photos or other files to be shown to, or described to, the players.

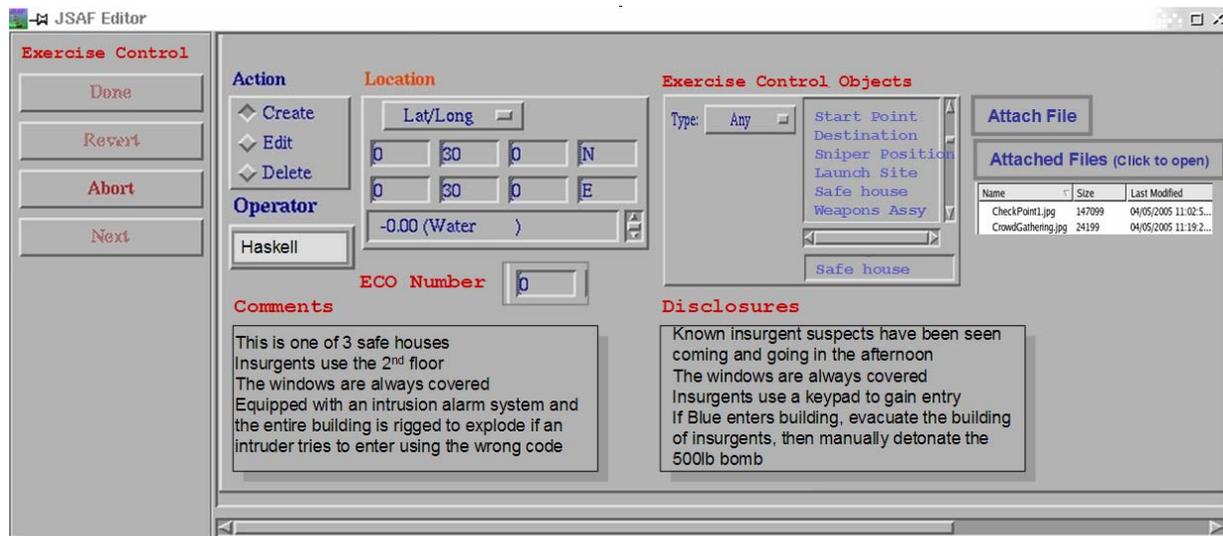


Figure 2 Exercise Control Editor

ECO objects are shown on the JSAF map below. The red, black and green arrows below are ECOs. The blue arrows are Situational Awareness Objects (SAOs) and the red triangle is a track object. The object shapes and colors are not significant in this example display. Controllers may select the attribute flags that they want to see next to the ECOs. For example, they may want to see the ECO number next to the object, or perhaps an abbreviation of the ECO comments, or the name of the person who created the ECO. This display shows an open Exercise Control Summary window at the bottom, that lists ECOs in a table format. The key information about the selected ECOs is shown in the Info Box in the upper-right.

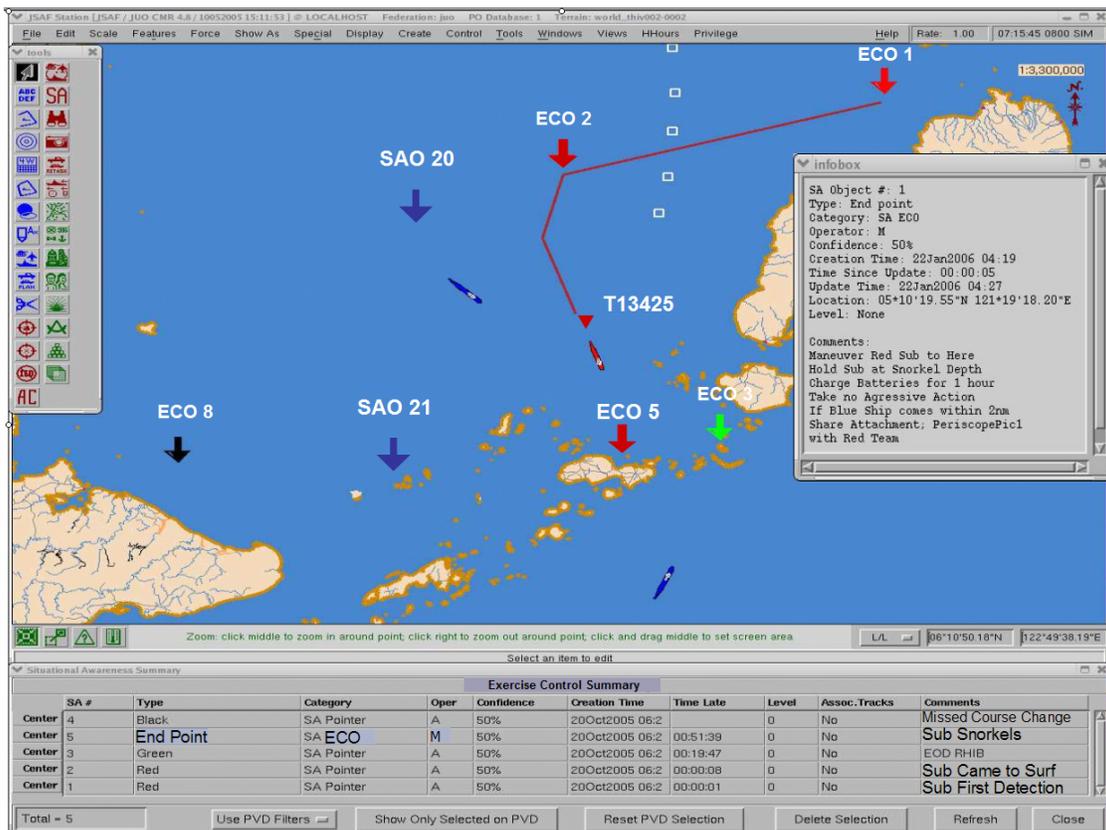


Figure 4 Map Display with ECO, ECOs and Tracks

The Exercise Control Summary, shown below, is similar the GCCS Track Summary, in that it shows the ECOs and associated attributes in a table format. Sim controllers often keep this display open during operations for ready reference. They can sort by any of the columns and open the ECO editor by clicking on the line item. The capability that sets the ECO process apart from other display tools, such as overlay objects in JSAF, is that the operator can easily find an ECO by clicking on the "Center" button to the left, which causes the map to center on the ECO. Often, sim controllers referred to ECOs by number in chat. This feature eliminated the need for sim controllers to type coordinates and long narrative descriptions in chat.

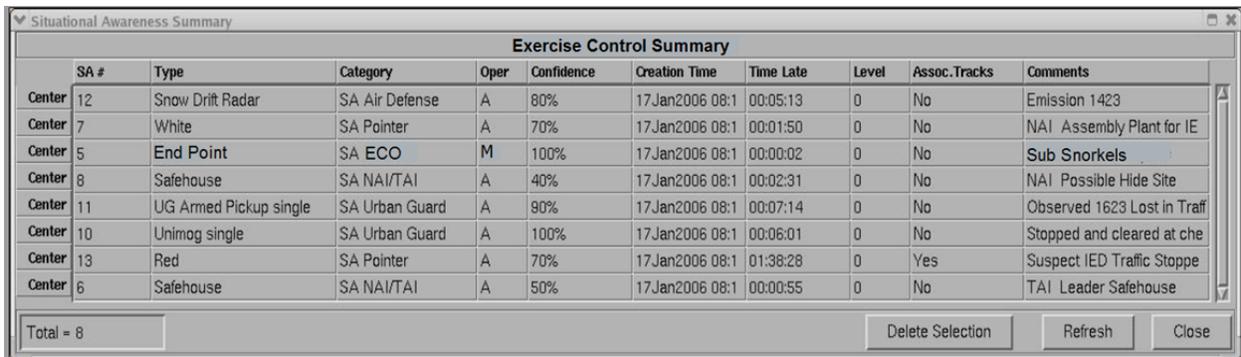


Figure 4 Situational Awareness Summary

The JSAF Info box shows the ECOs data when the controller clicks on the ECO map object. This feature makes it more convenient for operators to get information without the need for opening the editor. The Info box shows data for tracks, entities and other map features as well, so it is simply an extension of an existing JSAF query feature.

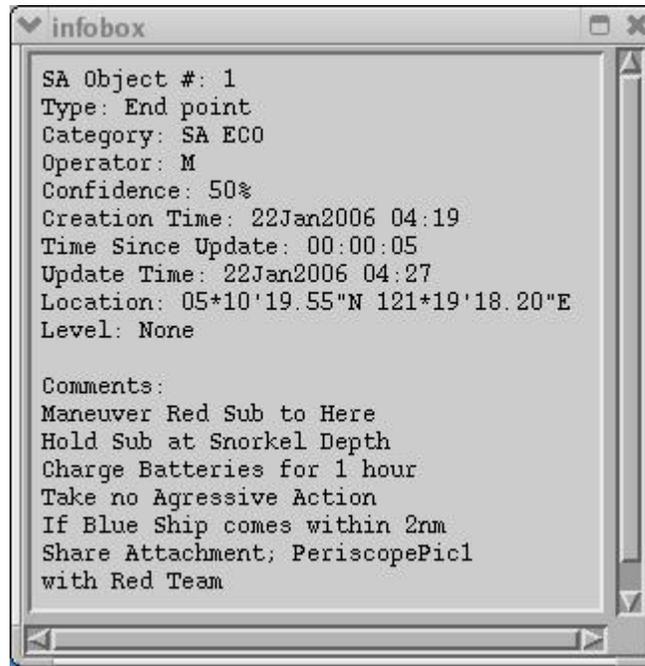


Figure 4 Information Box

Sim controllers use filters to select the types of SAOs and ECOs they want to view. The Exercise Control Group imposed filters to prevent the players from viewing the ECOs. The filter options shown below were tailored for various SAOs and included an ECO option. The filter option windows are implemented as pull-down menus that can be "torn off" so that they are always available on the display as windows for rapid manipulation. Future filters in JSAF will expand the ECO filter options to make them more useful to the controllers.

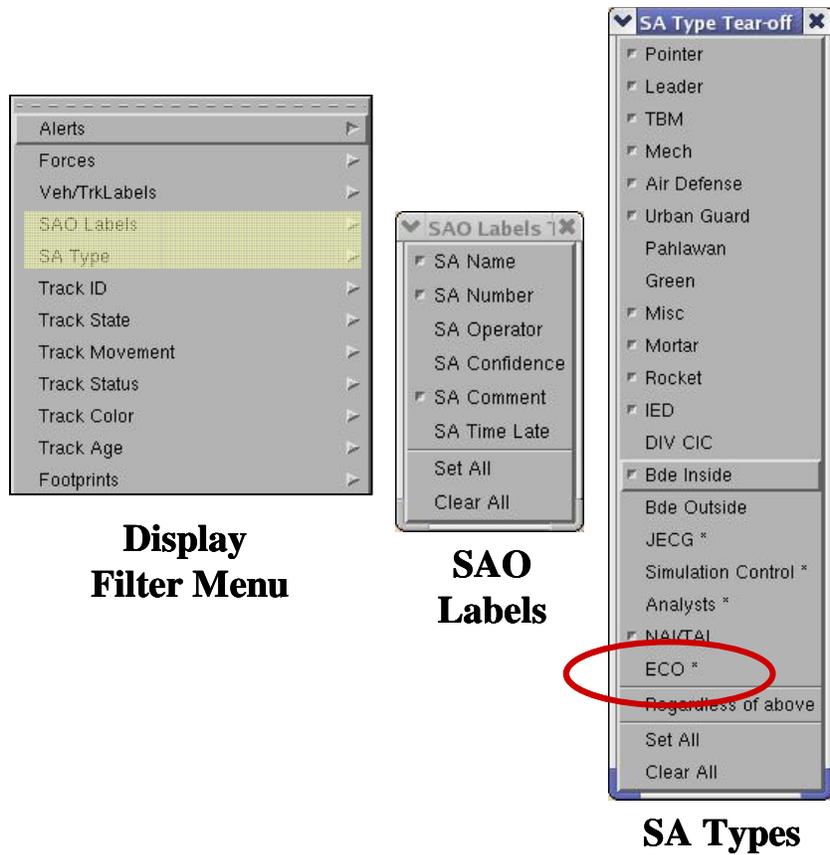


Figure 4 ECO Filters

JSAF includes an Alert Summary Display that allows controllers and players to select types of data for which they want to be alerted. For example, controllers may elect to be alerted whenever new ECOs are created or existing ones changed. This feature is useful when controllers are busy working on a task that requires them to be "zoomed in" on the map. In that condition, they might miss additions or changes to ECOs that they care about. Sim controllers kept this summary open and checked it occasionally to see if there was something going on that they were interested in. JSAF also includes pop-up alerts boxes that display over the map for very high-interest events. These alert boxes demanded the controller's attention, let them center on the object, or close the alert box. In UR05, the pop-up alerts were cued on detections of mortar or rocket launches.

Alert Summary Display							
	ID Number	ID / Category	Type	Switch	Create Time	Time Late	Oper
Center	ECO-00005	End Point	SAO ECO	ECO	07:20:10	00:00:33	M
Center	SAO-00006	SAFE House	NAI/TAI	SAO	07:20:10	00:00:33	R
Center	SAO-00012	Snow Drift Radar	Air Defense	SAO	07:20:10	00:00:33	T

Buttons: Clear All, Clear Selected, Use PVD Filters, Close

Figure 4 ECO Alert Summary Display

ECOs allow controllers to match information to a specific location in time. This function coupled with the ability to include an attachment with the ECO further helps sim controllers manage information. As shown below, an ECO referring to hostage taking incident could include attachments with a photo of the suspect building where the hostages are being held, a floor plan of the building, a photo of the hostage and suspects, the ransom note and other related information.

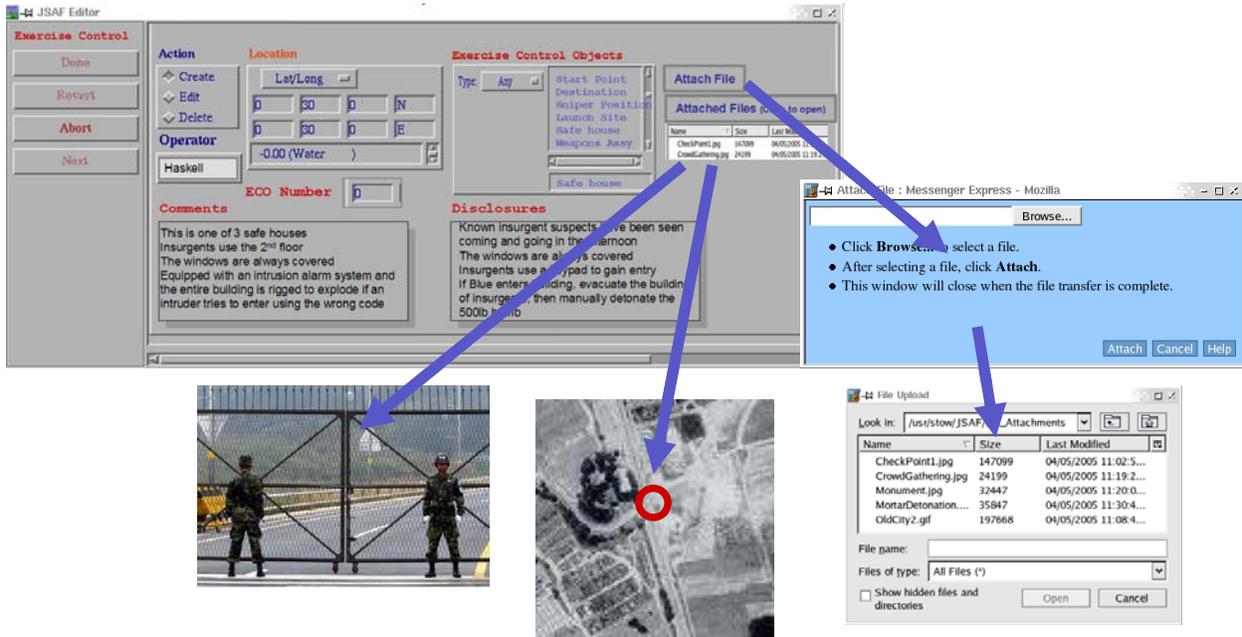


Figure 4 ECO Attach Feature

ECOs can be saved to spreadsheet at any time. This is a convenient method for capturing a snapshot of exercise control activity. The spreadsheet is easily saved as a Comma Separated Values (CSV) file for use with Microsoft Excel or other spreadsheet applications. The spreadsheet can be modified and then loaded back into JSAF. This offers a convenient method for preparing ECOs in advance for an event.

SAO NUMBER	SAO TYPE	CTP NAME	OPERATOR	OWNING FORCE	LOCATION	CONFIDENCE	ATTACHED FILES	COMMENTS	ASSOCIATED TRACKS	ATTACHED TO TRACK
5	SAO ECO	End Point		Blue	10GEV1843528583	100	Pic1.jpg	Move Sub Here		
6	SA NAI/TAI	Safehouse	R	Blue	10GEU4186480416	50		TAI Leader Safehouse		
7	SA Pointer	White	B	Blue	10GET6766391668	70		NAI Assembly Plant for IEDs		
8	SA NAI/TAI	Safehouse	A	Blue	10GET4014680864	40	Pic8.jpg	NAI Possible Hide Site		
9	SA Green	Crowd forming	A	Blue	10GET5450871966	70		Crowd picketing factory		
10	SA Urban Guard	Unimog single	N	Blue	10GEV3933203048	100		Stopped and cleared at checkpoint charlie		
11	SA Urban Guard	UG Armed Pickup single	A	Blue	10GET7005778730	90		Observed 1623 Lost in Traffic		
12	SA Air Defense	Snow Drift Radar	T	Blue	10GET4965074078	80		Emission 1423		
13	SA Pointer	Red	M	Blue	38SMB3572883733	70		Suspect IED Traffic Stopped at 1845 EOD called 1852 EOD arrived 1921	10021	10021

Figure 4 Spreadsheet

Processing of ECOs

ECOs are automatically transmitted over the network to a shared database, where they are assigned unique and sequential ECO numbers. The ECOs in the track database are made available to all the sim controller JSAF machines, depending on the filter settings and inhibited on player machines. System administrators can clear, save and reloaded the ECOs from the database. ECOs are also logged by the Future After Action Review System (FAARS).

The evolution of ECOs

The ECO evolved from the implementation and use of Situational Awareness Object (SAOs) in JSAF. Experiment subjects used Situational Awareness Objects (SAOs) to share their real-time awareness of the battlespace regarding activities of the adversaries, blue forces and civilian population. Throughout each JUO experiment, the SAOs structure evolved to include new options that were based on the controller's needs. The ECO was one example of these controller-driven improvements and are addressed more fully in second paper to be presented at this symposium. *Situational Awareness Object (SAO), A Simple Tool for Operational C2 Systems.*

The ECO Editor was designed to support expected controller inputs, with selectable options, based on the UR05 exercise constraints and objective. The Summary tables, filters and Info box and map symbols with attribute flags were designed, implemented and modified throughout the experiment trials. During the workup period for the experiment, sim controllers learned how to use the ECOs and their recommended changes to the ECO Editor and other displays were requested and encouraged. Changes were made over-night in many cases by software engineers. By the time the trials for record began, the sim controllers were very familiar with the use and value of ECOs. They began to accept ECOs as tools and exchanged information using ECO. They talked in terms of ECOs.

Prior to the implementation of ECOs, during each of the USJFCOM HITL experiments, sim controllers would rely on meetings and email from the exercise architects and the Exercise Control Group (ECG) to tell them what was expected regarding force placement and activities during the experiment. All the Sim controllers would independently translate coordinates and plot descriptive overlays on the JSAF map, along with the placement of simulated forces. After several iterative attempts at capturing the experiment construct, the ECG would approve the plan. The ECG would concurrently prepare an event activities document, similar to the military's Master Event Sequence List (MESL). Sim controllers used these MESL-like documents to determine the times to invoke discrete events in simulation. They would communicate with other sim controllers and the ECG by phone, chat or email to control the exercise tempo, timing of events and make changes throughout the experiment run. Because of the complexity and broad scope of these experiments, this approach was, in some cases, vulnerable to missed cues and incorrect actions.

With the advent of ECOs, the experiment architects and the ECG used ECOs to draft the construct of the experiment, placing SAOs and moving them around until they were satisfied with their plan. They would then save their SAOs to spreadsheet, using JSAF and share that spreadsheet for review. The ECG could use the spreadsheet to (cut and paste) details into the MESL. Sim controllers could load the spreadsheet file directly into their JSAF machines and begin to place simulated forces into JSAF and schedule their activities. This process simplified the task of plotting, recording and exchanging coordinates, reducing the plan-to-practice process

significantly, while it reduced plotting errors. Further, all the sim controller could see the entire event displayed symbolically on their map display and gain a better understanding of the scope and of activities adjacent to their area of responsibility.

During the event, sim controllers used the MESLs and ECOs to conduct the scheduled events. They used chat to coordinate the transition from one MESL event to the next and they did this by referring to relevant ECOs by number. Because the ECO Summary Display allows controllers to locate and center on specific ECOs, it became much easier for them to locate key locations and activities. They created ECOs during the events to share information and to provide a shared marker for other controllers to find. The ECO process significantly reduced the need for long chat messages and eliminated the need for controllers to exchange and find map locations by coordinates.

Analysts found that the use of ECOs helped them to keep track of the scenarios and better understand the activities of the experiment subjects as they reacted to dynamic events.

The J9 M&S team is testing the use of ECOs and the interface with Global Command and Control System (GCCS) as part of the ongoing UR2015 Experiment. JSAF interfaces with GCCS through a gateway. The ECOs appear in operational C2 systems as OTHGold JUNIT messages. ECO information that is not supported by existing JUNIT message fields are being placed in the JUNIT Remarks.

Recommendations for operational C2 systems

USJFCOM's success in using ECOs to enable the UR05 experiments and the enthusiasm and innovation that controllers show in using them, indicates this simple tool would be useful if implemented in various simulation and operational C2 systems.

The ECO capabilities can be implemented in existing simulation such as Battle Force Tactical Trainer (BFTT) or C2 systems, such as GCCS or web-based variants of tactical and operational collaborative tools. It is not important to duplicating the design and format of the JSAF ECO Editor, the ECO Summary and the filter process. The important thing is to capture the unique exercise control functionality for the target user, build a pretty-good prototype, then use it and get feedback from controllers. For best results, adopt an iterative process that enables direct support from software engineers.

Make the tools as simple to use as possible to use. Include relevant map symbols, with selectable attribute flags; give the controller the a ability to filter out ECOs that they do not want to see and provide an ECO summary table that allows controllers to center on the selected ECO. Extensive use of centering options significantly improves controller efficiency.

Study the controller missions and conduct a functional breakdown of information elements in a manner shown below. Use that study results to create relevant ECO menu items. To accelerate the refinement of effective menu items, create a function in the ECO Editor that will allow the controllers to create their own new menu items. This approach will encourage innovation on the controller's part and lead quickly to more useful and relevant ECOs.

Hostage taking	Public
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<p>event</p> <ul style="list-style-type: none"> Capture location Route Holding site Spotting location Release location Execution Location Press Release 	<p>Transportation</p> <ul style="list-style-type: none"> Train Station Ferry Landing Airport Terminal Bus Terminal Ship Terminal
<p>IED event</p> <ul style="list-style-type: none"> Storage Site Assembly Location Staging Location Route IED Placement Location Observer Location Safe house Press Release 	<p>Traffic</p> <ul style="list-style-type: none"> Accident Stopped Slow Diverted <p>Flooding</p> <ul style="list-style-type: none"> Rising Water Receding Water
<p>Fire</p> <ul style="list-style-type: none"> Municipal Commercial Residential Vehicular Brush Forest Fire Contained Fire Out 	

Figure 4 Notional ECO Categories

Consider and plan for ECO management. Just as GCCS tracks are managed, there needs to be procedures in place to allow for the deletion of ECOs. The USJFCOM sim controllers established business rules that declared that only the person who created the ECO could delete it. In an operational environment where many people may be involved with each ECO, it is likely that procedures that are more restrictive will be required. One option is to let controllers move ECOs into an inactive status. In conjunction with this action, create an automatic function that will alert and inform all controllers of the action. Give the controllers a filter that allows them to select to view inactive ECO objects.

Conclusion

The ECO process effectively allows planners to build exercises and experiments by placing ECOs directly on the map, in a geo-spatial environment. It allowed planners to collaborate by sharing their plans using the target applications; JSAF and GCCS. JSAF gives planners the ability to save their ECOs to spreadsheet and share them with simulation controllers and the exercise control group for force lay-down and execution, reducing the time required and possible errors caused by transposing locations into emails and planning documents.

The ECO process is effective during exercises as it allows controllers to collaborate in real-time and lets them visualize the details and scope of ongoing events. Further, ECOs as they compliment MESL events, allow controllers to easily locate activities on the map and they give them pointing tools that they can reference in chat.

ECOs, when logged by an after-action review system, provide a valuable link between what the controllers did and the players activity.

ECO functionality would be useful in other simulations and C2 tools where multiple controllers need to work together to share their intentions and plans regarding geo-spatial events and activities in a time-critical environment.

Just as sensor-level detections and tracks are generated and shared among tactical decision-makers using operational C2 tools, ECOs allow the Exercise Control Team to create and shape the tactical environment for exercises in a collaborative manner.

The USJFCOM, J9 Modeling and Simulation (M&S) Support Team's implementation of the ECO process serves as a pretty-good prototype that offers some suggestions and tools that have proven useful to Exercise Controllers.

References

1. Situational Awareness Object (SAO), A Simple Tool for Operational C2 Systems (2006)
Michael Anhalt and Laura Dunleavy 2006 CCRTS paper #