

# **ARI Contractor Report 2011-01**

## **Joint Measurement Operations Controller (JMOC)**

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**January 2011**

**United States Army Research Institute  
for the Behavioral and Social Sciences**

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# JOINT MEASUREMENT OPERATIONS CONTROLLER (JMOC)

## EXECUTIVE SUMMARY

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### Research Requirement:

Training for today's military has evolved into a complex interaction of systems of systems including live, virtual and constructive simulations. Therefore, accurately recording the range of relevant trainee behavior is becoming increasingly challenging. Capturing and integrating observer-based measures with system-based measures and data provides a more complete picture of trainee performance. The JMOC project focused on developing useful technology to capture observer measures and comments, so key information observed during exercises is available for After Action Reviews and other post-exercises products. The purpose of the current project was to develop a tool to enhance Joint Exercises by facilitating the incorporation of observer-based measures with system-based information to enhance training.

### Procedure:

Interviews were initially conducted with Observer Trainers (OTs) at Joint Forces Command (JFCOM) J7 Operations Group to identify requirements for developing an observer measures tool. Through the course of these interviews a number of issues were identified in terms of work load, application to current AAR needs and further research issues. While an observer-based measurement tool could be useful, it would have limited benefits in the current operations environment due to barriers to adoption. As part of this research a demonstration was developed using the SPOTLITE™ tool. This demonstration gained the interest of the JFCOM J7 Capabilities Development Group which made it possible to transition the focus of JMOC efforts into integrating with the Joint After Action Review Repository Library (JAAR). The JAAR provided both a rich technology base and opportunities to work with potential end users at a variety of training exercises.

### Findings:

This effort integrated SPOTLITE technology into the JAAR, providing observer-based measurement capability to the overall system. Feedback from both JAAR engineers and end user trainers was positive. They appreciated the ease of use and felt the tool provided missing observer-based measurement capability, enhancing their data collection efforts to date.

### Utilization and Dissemination of Findings:

Through the integration of SPOTLITE into the JAAR architecture the JMOC project now makes observer-based measures available for incorporation into a number of JAAR components and reporting functions. These observer-based measurement capabilities are now available to any organization or component where the JAAR Suite is installed and integrated into training exercises. In addition, the resulting SPOTLITE-based JMOC technology can be used independently of the JAAR.

## ABSTRACT

Training for today's military has evolved into a complex interaction of systems of systems including live, virtual, and constructive simulations. Therefore, accurately recording the range of relevant trainee behavior is becoming increasingly challenging. Capturing and integrating observer-based measures with system-based measures and data is necessary to provide a complete picture of trainee performance. The JMOC project focused on developing useful technology to capture observer measures and comments, so key information observed during exercises is available for After Action Reviews and other post-exercises products. JMOC successfully integrated the proven SPOTLITE platform for collecting observer-based measures into the JAAR-RL (Joint After Action Review Repository Library). JMOC provided measures for supporting military exercises and the JAAR program itself, by capturing performance on installation and training for JAAR integrations and deployment. JMOC accomplishments constitute a foundation for transitioning other measurement technologies into the JAAR. In addition, the JMOC SPOTLITE-based tool can be used in military training settings independently of the JAAR.



# JOINT MEASUREMENT OPERATIONS CONTROLLER (JMOC)

## CONTENTS

	Page
Problem.....	1
Approach.....	1
Procedures.....	2
Results.....	4
Discussion.....	12
References.....	15
APPENDIX A: JMOC MAWTS MEASURES.....	16
APPENDIX B: JMOC – JAAR FUNCTIONAL NEEDS ASSESSMENT MAREIX.....	17
APPENDIX C: JMOC – JAAR MEASUREMENT SET.....	22
APPENDIX D: AVAILABLE SPOTLITE DYNAMIC TARGETING CELL (DTC) MEASURES .....	24
APPENDIX E: SUMMARY OF DIGITAL PEN/PAPER TECHNOLOGIES.....	38

## LIST OF FIGURES

FIGURE 1: JMOC INITIAL INTEGRATION DESIGN.....	3
FIGURE 2: SPOTLITE MOCK-UP FOR JMOC DEMONSTRATION .....	5
FIGURE 3: SUMMARY OF OBSERVER BASED COMMENTS .....	6
FIGURE 4: PROTOTYPE ANALYST TOOLKIT INTERFACE.....	8
FIGURE 5: ADDITIONAL PROTOTYPE ANALYST TOOLKIT INTERFACE DESIGN .....	9
FIGURE 6: PROPOSED INTEGRATION OF OBSERVER-BASED MEASURES INTO JAAR PLAYBACK.....	11



## JOINT MEASUREMENT OPERATIONS CONTROLLER (JMOC)

### Problem

Currently, performance measurement, assessment, and feedback for trainees in Joint training exercises rely heavily on observations made by Observer Trainers (OTs) and Observer Controllers (OCs). Observers are responsible for recording observations of trainee performance and providing real-time feedback during exercises, facilitating After Action Reviews (AARs), and creating useful exercise summary products. However, observer-based data collection presents several challenges. Using current paper and pencil methods, it is difficult to collect and organize observations efficiently, to correlate and fuse observations in accordance with training requirements, and to use synthesized data to produce coherent AAR and exercise products. Moreover, given the complexity and volume of the data obtained by instrumented systems used in training, the sheer number of systems and observers involved, and the distributed nature of live, virtual, and constructed (LVC) training events, it is often difficult to establish the exercise context under which observations are collected. Thus, there is a clear need for enhanced performance measurement and assessment capabilities in LVC environments.

There is an important pragmatic aspect to the problem of more effective and flexible methods for collecting observer-based data: OTs and OCs operate within an organizational and operational context, with defined workflows and within significant time and resource constraints. New technology must be compatible with those constraints and with the operating procedures and expectations of the OTs and OCs. Therefore, **the problem the Joint Measurement Operations Controller (JMOC) project sought to address combines technical and operational aspects**. This is not unique to JMOC, of course: successful development and introduction of new technology requires both the technology itself and its adoption, and therefore the development of the technology must be informed by considerations of its operational settings. It is also important to note that those operational settings have important technical components as well, in terms of the technologies currently employed, and effective technology development and introduction must be responsive to those requirements as well.

### Approach

The Joint Measurement Operations Controller (JMOC) project required identification of a suitable user group so development could focus on actual user requirements. It was necessary that the identified user group be interested in potentially using JMOC, since it was neither feasible nor appropriate to attempt to impose a solution. JMOC began by focusing on computer-based tools to facilitate data collection and analysis by OCs and OTs for Joint Training exercises. Initial efforts were geared toward developing a tool for use by the OTs in the JFCOM J7 Operations Group within their current work environment. As work continued, the focus of the JMOC project shifted to the Joint After-Action Review Repository Library (JAAR) activity coordinated by JFCOM.

The JAAR is an engineering activity concerned with integrating a variety of existing and new capabilities into a suite of tools that can support a variety of military training exercises. JMOC activities with the JAAR involved both technology development and integration, on the

one hand, and actual support of field exercises, on the other, providing suitable exposure to end user requirements as well as a realistic context for technology development.

The procedures that implemented these methods are discussed in more detail below.

## **Procedures**

To better understand the needs of end-user, meetings were held with members of the JFCOM J7 Operations Group early in Phase II. These meetings were used to define requirements and establish expectations for JMOC given the organizational structure at JFCOM, as well as to understand the hurdles and requirements that must be addressed for the program to be successful. Additionally these meetings revealed to the team the current research being conducted on the mapping of training results to Doctrine, Organization, Training, Material, Leadership and Education, Personnel and Facilities (DOTMLPF) issues.

Meetings were held with JFCOM J7's Capabilities Development Group to discuss better understand their role with J7. It was learned that the Capabilities Development Group's mission is to develop future capabilities to improve joint training. These meetings were to determine if and how current efforts could be transitioned into these future capabilities. As part of this research the JAAR-RL program was introduced and their Engineering Group efforts to develop a system of systems to integrate current Joint After-Action Review capabilities based on existing technologies in use across services.

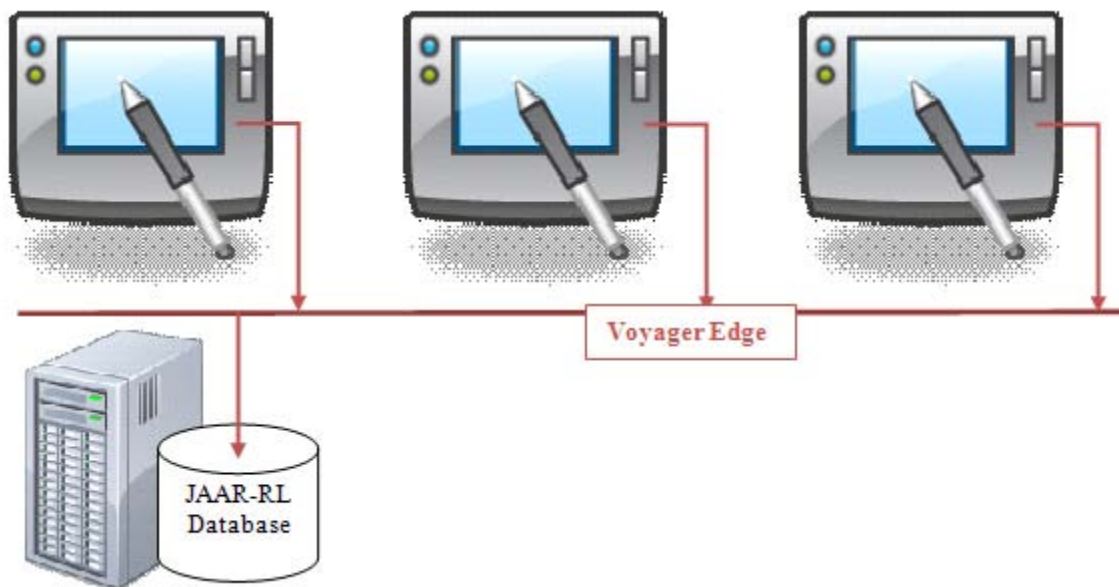
Research with both groups showed two distinct perspectives. The Operations Group focused on the pragmatic issue of ensuring that technology integrates into the users' workflow and processes. Additionally, the Operations Group focused on delivering material into the final end product of training they saw as most valuable: the Commander's Summary Report (CSR).

The Capabilities Group's perspective was more focused on engineering and technology considerations to collect and coordinate the varied data sources to provide a more complete review of the training exercises. The JAAR-RL program collected digital data in various formats and protocols into a central repository but lacked a means to collect and include observer-based measures. However, the JAAR-RL program's Functional Needs Assessments (see Appendix B) specifically identified requirements for observer-based measures. JMOC was viewed as a potential component to fulfill this need for observer-based measurement.

After detailed assessment of these two distinct perspectives this effort focused on integration with the JAAR-RL project. The decision was based on three main factors: first, Aptima's SPOTLITE application for collecting observer-based measures had been identified by the JAAR-RL for integration, which ensured that the basic requirement of a perceived user need was met. Second, the integration of existing technologies within the JAAR-RL's architecture showed a clear transition path to deployment of the observer-based measurement capabilities to support joint training exercises. And third, active participation in the JAAR would involve participation in real training exercises where the technology would be used and could be evaluated by potential end users.

With a new end-user identified, the team attended its first the JAAR Engineering Group meeting held at the Joint Development and Integration Facility (JDIF) in Orlando, FL in January 2008. At the meeting the SPOTLITE platform was introduced, along with the larger A-Measure suite and a concept of measurement in training. We were introduced to the JAAR RL

Architecture, based on the Voyager Edge communications protocol, intended to enable each component of the JAAR to connect and exchange information within the JAAR system. Technical information for the Recursion Software Voyager Edge platform was provided. The initial design of the integration of JMOC with the JAAR via Voyager Edge is shown in Figure 1.



*Figure 1. JMOC Initial Integration Design*

Documentation was made on how the SPOTLITE tool could support the JAAR functional requirements. The provided documentation for the JAAR Functional Needs Assessment (FNA) was reviewed and a matrix of what functions would be supported or supplied by the three main components of the JMOC project – SPOTLITE, Voyager Edge (VE), and the Analyst Toolkit. The detailed summary is in Appendix B.

A developer's license for VE was obtained from the JDIF to continue with the integration efforts. Previously Aptima was using an evaluation license that was sufficient for the initial testing; however the software engineers felt using the full developer's license should avoid any integration issues when the product was delivered testing. Our team developed, tested and integrated SPOTLITE with the preferred method of using a database VE agent.

Integration efforts continued with the Recursion Software VE technology. We transitioned from the web services interface to using a VE database agent communicating with a Postgres database. The JAAR Engineering Group provided a data collector manager specification and we integrated with this updated specification.

The JAAR integration and architecture meeting in May 2008 at the JDIF in Orlando, FL. Provided a venue to present the existing capabilities of the JMOC extended SPOTLITE tool for collecting observer-based measures. Additionally, information was provided on how SPOTLITE fits into the larger A-Measure suite and how the COMPASS process for developing measures could be used by the JAAR for both observer- and system-based measures.

As a result of the meeting team members provided documentation for: system integration, SPOTLITE system requirements, and the Authority To Operate (ATO) process as requested by the JAAR. In addition, work continued with the integration efforts of SPOTLITE with the JAAR VE architecture.

## **Results**

The initial work on the JMOC project consisted of research into applying technologies for allowing Observer Trainers (OTs) to electronically capture exercise observations. This work included evaluation of electronic paper and handwriting recognition software. Neither of these technologies was sufficiently robust to provide a feasible solution. Additionally, incorporating these technologies would have excessively increased workload for both the OTs and analysts.

Existing, proven technology was leveraged (Alexander, et. al. 2007) to demonstrate how an observer-based tool could be configured and deployed to capture a rich set of observer-based measures for use in training exercises. JFCOM provided a Collection Management Plan (CMP) to develop a set of measures for use in the SPOTLITE™ tool developed originally for the Air Force Research Lab (and now in use in Air Force, Army, and Marine settings).

Two initial prototypes were developed under the JMOC project: (1) an OT Tool based on the SPOTLITE platform and (2) an Analyst Tool for reviewing multiple OT observations. These tools were based on review of the JFCOM-provided Ardent Sentry exercise documentation (Commander's Summary Report and Collection Management Plan) and the initial discussions with JFCOM and the DOTMLPF study presentation.

Figure 2 shows the SPOTLITE demonstration with the left side displaying the navigation tree for the items OTs should be mindful of during the exercise. The larger right side of the screen contains the various prompts for the OT observations. Essentially, the tool instantiates the CMP directives to the OTs and provides the guidance and reference for them to enter their observations.

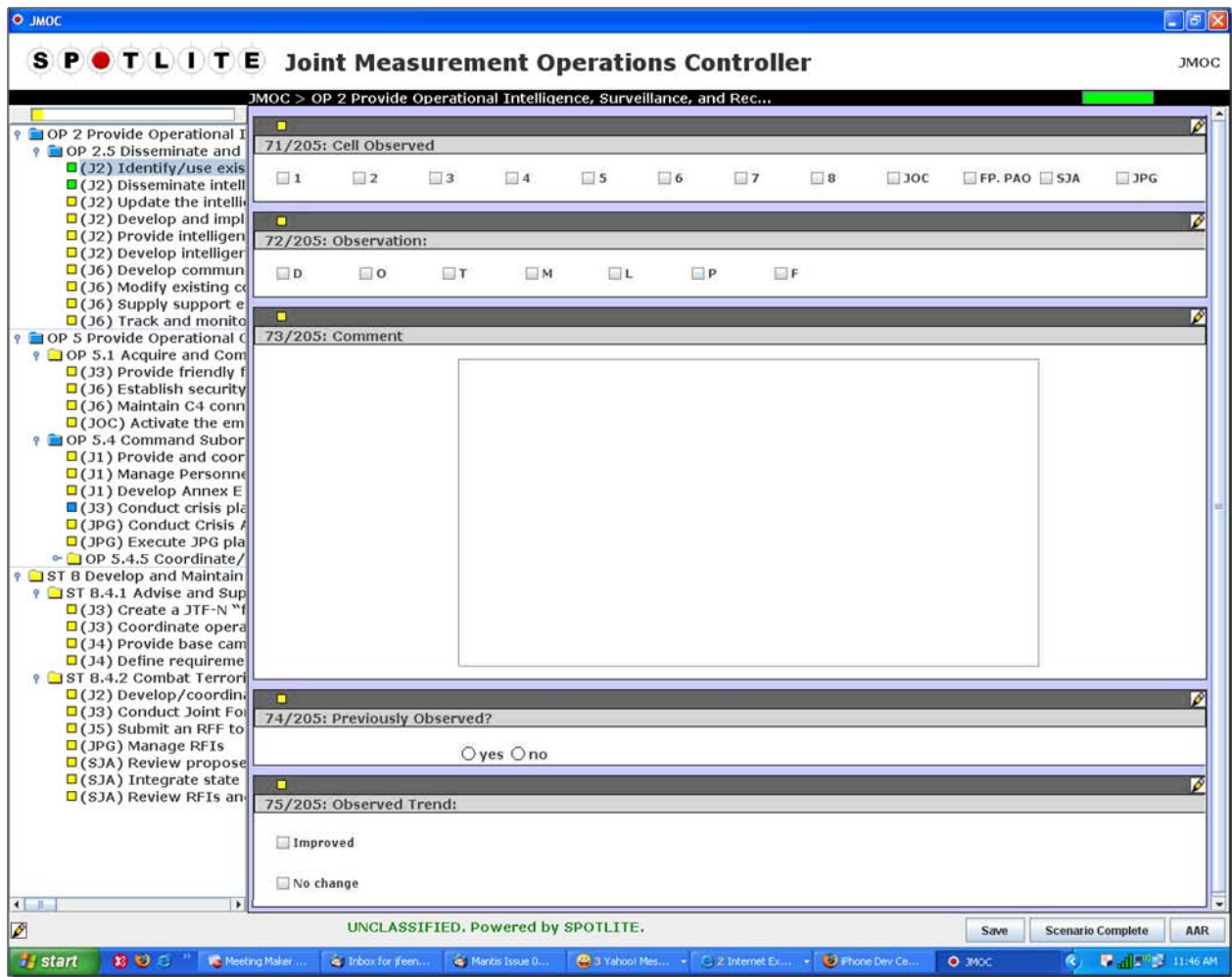


Figure 2. SPOTLITE Mock-up for JMOC Demonstration

In addition to the JMOC OT Tool, an Analyst Tool prototype tool was designed. This would allow for additional functions relating to „scrubbing“ observations for use in various end products: AAR, CSR and DOTMLPF. Once all the observations are collected in SPOTLITE and downloaded to a repository the analyst would use the a tool depicted in Figure 3 to find, filter and review the observations made by OTs during the exercise.

ID	Comment	Obs Cell	Obs Type	Observer	ReportDate	Prev Obs	Trend
2.5.2	This is the first test second line	1,2	Doctrine	Yale Marc	2007-11-30 09:0	no	No change
2.5.3	This is Bill Jones entry	1,3,JOC	Training,Material	Bill Jones	2007-12-03 11:2	no	No change
8.4.1.2	This is the first one answer	1,3,JOC,FP, PAO	Doctrine,Organiz	Yale Marc	2007-12-03 04:4	yes	No change
2.5.5	Second One	2,4,SJA	Material,Leadersh	Yale Marc	2007-12-03 04:4	yes	Improved

Figure 3. Summary of Observer Based Comments

A demonstration of December 2007 of these tools at JFCOM Suffolk, VA formally introduced the team to the Joint After Action Review Repository Library (JAAR-RL) program. The demonstration feedback and follow-on discussions were quite encouraging. At this meeting JMOC's focus and direction was changed. Our end-user was changed from the JFCOM J7 Operations Group to the JAAR project. Our new direction consisted of integrating our existing technology (SPOTLITE) into the JAAR Architecture to provide observer-based data collection and measures for previously defined functional requirements. The remainder of our work in JMOC focused on our newly identified end-user and the functional requirements of the JAAR.

With the adoption of any technology effort gaining acceptance from the user is vital to success. From our work with the OTs it was apparent their organizational culture was resistant to adopting new tools and techniques for capturing observer-based measures digitally. While the requirements identified – the digital capture, storage and retrieval of observer-based measures – were technically feasible, the OT community's inability to change their current workflow and processes placed constraints on JMOC development efforts that could not be overcome.

The two largest constraints of the OT community were that the process of recording observations remains hand-written and that there could no increase in current workload of OTs and their analysts. Through an evaluation of the available technologies for capturing, storing and retrieving observer-based measures no technical solution was identified that satisfied these constraints. For example, although digital pen/paper would allow an OT to digitally capture observation notes but placed additional workload on the analysts, the effort needed to process the notes for use in exercise products (e.g. AAR & CSR) and research/training enhancements violated the workload constraint. Given the results of our research into the various technologies none of the digital paper/pen technologies no combination of products provided a feasible solution for JMOC. (See Appendix E for a summary of Pen/Paper technologies).



JMOC formally joined the JAAR Engineering Group in January 2008 and proceeded to integrate SPOTLITE™ with the JAAR Architecture, specifically integrating with Recursion Software's Voyager Edge platform – a distributed communication protocol for establishing, securing, and performing communication in a network of heterogeneous devices. The first integration effort included both real-time (wireless/wired) and late join (batch upload) capabilities. Both versions were developed to ensure that real-time data collection could be supported in exercises where the network and security constraints would allow such access and also ensure that data could be captured when such connectivity was not available.

Given the change in direction based on the requirements of the JAAR, a proven technology was selected to demonstrate how an observer-based tool could be configured and deployed to capture a rich set of observer-based measures for use in training exercises. A JFCOM-provided Collection Management Plan (CMP) was used to develop a set of measures for use in the SPOTLITE™ tool developed originally for the Air Force Research Lab (and now in use in Air Force, Army, and Marine settings). This existing observer-based collection tool™ is a component of a larger suite of capabilities to integrate all aspects of performance measurement in distributed training exercises: measure definition; collection of system-based, observer-based, and self-report training data; analysis; and display. Additional components of this existing suite of tools can be integrated into the JAAR to help address their important requirements for assessing, maintaining, and enhancing military readiness and training for both current and future forces. This is consistent with the core approach being pursued by the JAAR, which is to integrate and thereby leverage existing tools and technologies, and can provide solutions to a number of the JAAR functional needs addressed in the JAAR Functional Needs Assessment.

SPOTLITE™ was successfully integrated into the JAAR architecture and demonstrated at the Marine Aviation Warfare and Tactics Squadron exercise (MAWTS) 09-1 in October 2008. For supporting testing and evaluation of observer-based measures at this service-level exercise, measures were developed based on an existing data collection process at MAWTS. The measures represented a key subset of the total observations made at the exercise and demonstrated the first collection of observer-based measures in a JAAR supported exercise. At the exercise the JMOC team accomplished:

- Installing JMOC's SPOTLITE software on the MAWTS supplied Toughbook.
- Collected field data in parallel with MAWTS personnel.
- Configured the software to accomplish the late join (batch upload) for the new IP addresses on the MAWTS equipment.
- Successfully loaded observer-based data from the Toughbook into the JAAR database.

Observer data was collected in real time and provided to the JAAR via the late-join capability upon return from the field. (See Appendix A for an Excel spreadsheet showing the data that were collected.) These data requirements were developed with MAWTS personnel on-site at the exercise and therefore are not as detailed as measures developed using the COMPASS process and implemented in SPOTLITE. This was a successful and well-received demonstration of collecting observer data in an exercise supported by the JAAR.

In addition to SPOTLITE integration, work included development of initial concepts for the Analyst Toolkit interface. The Analyst Toolkit would enable analysts to monitor, search, and

filter observer-based measures collected in an exercise. Figure 5 is a prototype interface developed and shown to the JAAR Engineering Group.

While the SPOTLITE tool is integrated with the JAAR Architecture it physically resides on individual observer tablet PCs or PDAs. The SPOTLITE user interface is independent of other applications residing within the JAAR Workstation. In contrast, the Analyst Toolkit resides on and is operated at the JAAR Workstation. Prior to the integration of SPOTLITE's observer-based measurement capability there was no need for an analyst tool to support those measures. A number of interface designs were produced to illustrate how an analyst tool could be used to find, filter and explore the observer-based measures. Figures 4 and 5 show Analyst Toolkit prototype designs developed for the JAAR. While the prototypes for the Analyst Toolkit were well received further development was postponed in favor of other higher priority tasks for the JAAR Workstation.

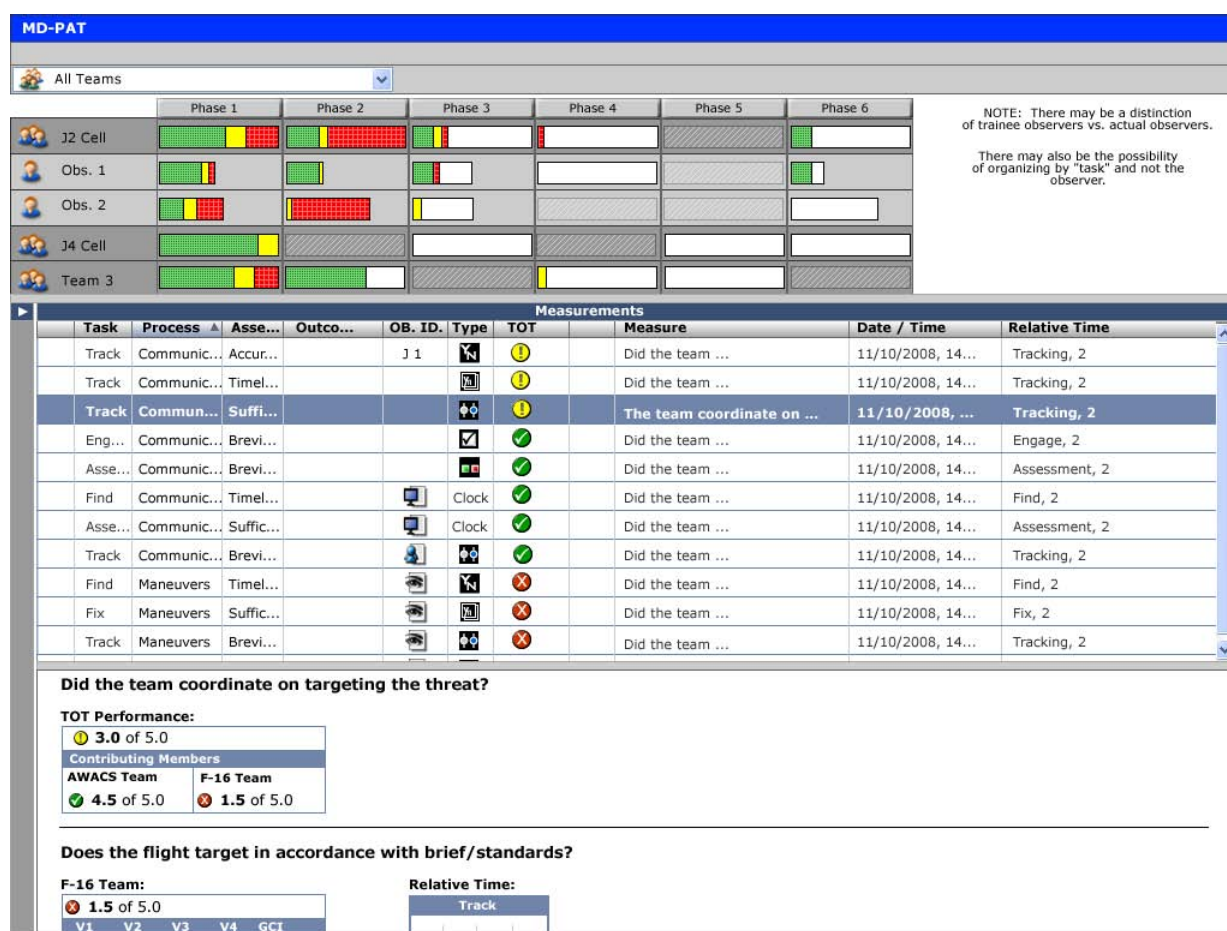


Figure 4. Prototype Analyst Toolkit Interface

Data Selection

Date range and VUL

From:

Nov. 08 2008

To:

Nov. 08 2008

VUL:

VUL 11082008 10:00:00

VUL Start:

10:00:00

VUL End:

11:00:00

Data Filters

VUL Timeframe Filter

Start:

10:00:00

End:

11:00:00

Teams Filter

AWO

☒

Elsworth (AWO)

☒

Mesa (AWO)

☐

Tinker (AWO)

F-15

☐

F-15

F-16

☒

Elsworth (F-16)

☒

Mesa (F-16)

☐

Tinker (F-16)

Timeline Summary

Statistics Summary

MECs

Measure Data

Advanced Data Filters

Platform	Weapon	Performance	Category	Type	MECs	SCs	Time / Date	Measure
F-16 (Mesa)		✗			Directs/M...	Adaptab...	10:35:45 11/08/08	Did the team ...
F-16 (Mesa)		✗			Fixes/Tra...	Commun...	10:45:25 11/08/08	Did the team ...
F-16 (Mesa)		✗			Direct/...	Decisio...	10:25:45 11/08/08	Does the flight tar...
F-16 (Elsworth)	Sidewinder	✗			Fixes/Tra...	Internal T...	10:21:55 11/08/08	Did the team ...
AWO (Mesa)		✗			Fixes/Tra...	External ...	10:32:54 11/08/08	Did the team ...
F-16 (Elsworth)	Sidewinder	✗			Plans an...	Plans an...	10:12:56 11/08/08	Did the team ...
AWO (Mesa)		✗			Organiz...	Commun...	10:56:45 11/08/08	Did the team ...
F-16 (Elsworth)		!			Employ...	Plans an...	10:32:21 11/08/08	Did the team ...
AWO (Mesa)		!			Fixes/Tra...	Multitas...	10:34:54 11/08/08	Did the team ...
F-16 (Mesa)	Sidewinder	!			Employ...	Situation...	10:21:59 11/08/08	Did the team ...
F-16 (Mesa)		✓			Fixes/Tra...	Decision...	10:04:45 11/08/08	Did the team ...
AWO (Mesa)		✓			Fixes/Tra...	External ...	10:32:54 11/08/08	Did the team ...
F-16 (Elsworth)	Sidewinder	✓			Plans an...	Plans an...	10:12:56 11/08/08	Did the team ...
AWO (Mesa)		✓			Organiz...	Commun...	10:56:45 11/08/08	Did the team ...
F-16 (Elsworth)		✓			Employ...	Plans an...	10:32:21 11/08/08	Did the team ...
AWO (Mesa)		✓			Fixes/Tra...	Multitas...	10:34:54 11/08/08	Did the team ...
F-16 (Mesa)	Sidewinder	✓			Employ...	Situation...	10:21:59 11/08/08	Did the team ...
F-16 (Mesa)		✓			Fixes/Tra...	Decision...	10:04:45 11/08/08	Did the team ...

Does the flight target in accordance with brief/standards?

F-16 Team:

✗ 3.0 of 5.0

V1	V2	V3	V4	GCI
!	✗	✗	✗	✓

Observer Notes:

Comments...

Figure 5. Additional Prototype Analyst Toolkit Interface Design

The main efforts for integration of SPOTLITE into the JAAR architecture included the following software development and testing tasks:

1. Refactored SPOTLITE to persist data to a target database environment based on a parameterized set of variables.
2. Migrated the OBSERVER DB schema from SQL Server to PostgreSQL
3. Integrated SPOTLITE with the JAAR Data Collector Manager (DCM) software
  - a. SPOTLITE can be launched from the JAAR DCM and accepts parameters passed from the JAAR
  - b. SPOTLITE persists data to its own schema within the JAAR database
  - c. SPOTLITE captures and persists the event and session data and associates its observations with the unique (event and session ids) JAAR identifiers
4. Implemented all the abstract methods of the JAAR Abstract Data Collector so that SPOTLITE can respond to the requests and instructions of the JAAR operators.
5. Updated SPOTLITE for the new JAAR Communication Layer that superseded the Voyager Edge protocol.

9

Additionally as part of the JAAR Engineering Group, numerous requests were addressed, including the following:

1. Provided complete IATO documentation for SPOTLITE and its component software to the JAAR manager.
2. Provided an Aptima Panasonic Toughbook for use at the JDIF while procurements for JDIF's Toughbooks are underway.
3. Provided application installation instructions and supporting documentation.
4. Provided various software engineering documentation for JAAR programmatics – e.g. SLOC measure.

After the success at MAWTS, the JMOC project focused on integration into the new JAAR Communication Layer (JCL) being actively developed internally by the JAAR at the Joint Development and Integration Facility (JDIF). The JCL was designed to replace the Voyager Edge communication protocol. This integration effort consisted of a number of iterations as the JCL evolved and matured. The result of this effort concluded with successful participation in the integration event held at the JDIF in May, 2009. Additionally, while at the JDIF Aptima worked with JDIF personnel to develop and implement a set of measures to assess the installation of the JAAR suite. This version of SPOTLITE™ allows the JAAR Engineering Group to observe and evaluate the JAAR installations at any site and have the data available for post-hoc and trend analysis. This will help make the installation process more effective and efficient. Acceptance of the SPOTLITE technology and associated measurement approach represents a gratifying level of acceptance by the JAAR community of top-caliber engineers. They have come to believe that the technology, and the measurement and analysis it makes possible, can add value to their own efforts, an endorsement quite distinct from those of end users in the training world.

Integration with the newest version of the JAAR Communication Layer (JCL) was completed by improving the user experience via adjusting where certain communications with the JAAR occurs. In the previous version of the JAAR communication layer using Voyager Edge, the communicating began after loading the setup page. In the JCL version of the conops the interactions happens sooner. Earlier communication was established in the application's sequence timeline to improve the user experience.

For the majority of the JMOC project the main focus of the JAAR was on collection from various data sources, (e.g. HLA, TENA, DIS, SPOTLITE, etc.). From an engineering perspective, focusing on system-based or observer-based measures was premature until data collectors were established for the JAAR. The JMOC team's expertise in measures and measurement development, while recognized, was not fully utilized due to the efforts in establishing the data collectors. However, in January and February 2009 the JMOC team participated in a series of JAAR Use Case development discussions and meetings where the focus shifted from data collection to measurement. The team presented how to incorporate the observer-based measures into the set of JAAR reporting tools. These ideas included:

- Establishing a Java measure tree plugin to JAAR Playback tool that would allow for the following functionality:
  - Time-stamped display of measures that could drive playback from a tree (using JCL playback messages)
  - Timeline tool where indicators of measures show up on timeline.



- The concept would apply to both observer-based and system-based measures when they are available.

Figure 6 shows how observer-based measures could be integrated into a JAAR playback capability. The analyst would be able to select measures from the top left hand side of the display. Overlays of various data sources are selected on the lower left of display. The time line and playback are on the right side of the display. Measure icons are lower right below the playback controls.

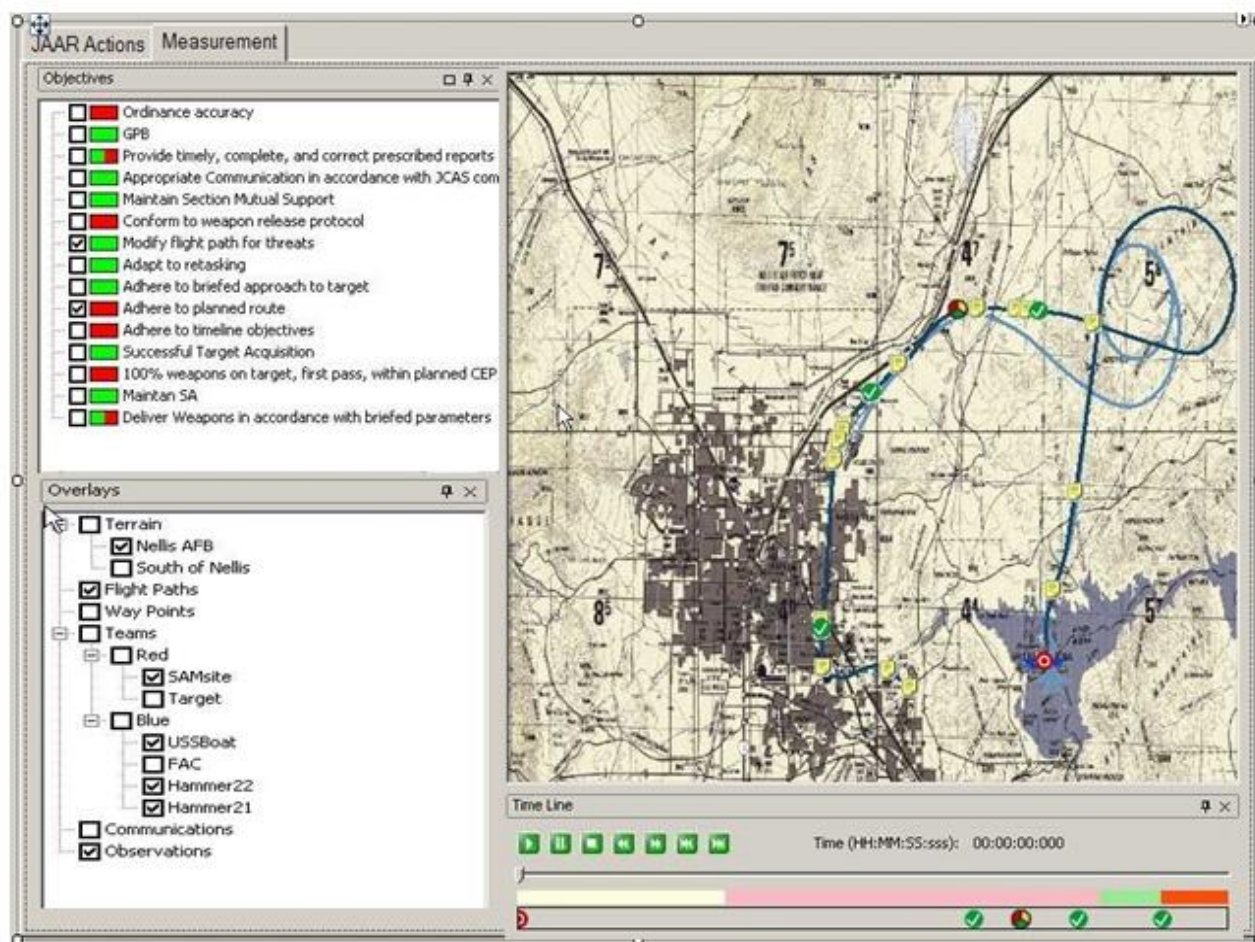


Figure 6. Proposed Integration of Observer-Based Measures into JAAR Playback

In addition to the software development tasks performed, the JMOC team worked in three different areas for integration of observer-based measures within the JAAR: Joint Training exercises, a service level exercise, and for internal use by the JAAR Engineering Group.

For supporting testing and evaluation of observer-based measures JMOC supported the service level exercise at the USMC Marine Air Weapons and Tactics Squadron (MAWTS). Measures were developed based on an existing data collection process at MAWTS. The measures represented a key subset of the total observations made at the exercise and

demonstrated the first collection of observer-based measures in a JAAR supported exercise. The exercise accomplished:

- Installing JMOC's SPOTLITE software on the MAWTS supplied Toughbook.
- Collected field data in parallel with MAWTS personnel (See Appendix A).
- Configured the software to accomplish the late join (batch upload) for the new IP addresses on the MAWTS equipment.
- Successfully loaded observer-based data from the Toughbook into the JAAR database.

No formal evaluation of SPOTLITE was performed with the JAAR Engineering team. As noted above, the focus of the JMOC project was on integration with and support of the JAAR. Several JMOC program accomplishments serve as explicit, face-valid indicators of positive assessments by the JAAR:

- 1) SPOTLITE was integrated into the JAAR;
- 2) SPOTLITE was used to support a number of exercises the JAAR was involved in;
- 3) discussions have been held about increasing SPOTLITE use within the JAAR-RL program and integrating additional software components associated with SPOTLITE; and
- 4) SPOTLITE measures were developed for use by the JAAR itself to enhance JAAR installation procedures, as discussed below.

To support the JAAR Engineering Group a set of measures were developed for the installation and integration of JAAR suite. By establishing a set of measures for use in SPOTLITE engineers would have a stable set of measures when delivering and training users of the JAAR suite. This version of SPOTLITE™ allows the JAAR Engineering Group to observe and evaluate the JAAR installations at any site and have the data available for post-hoc and trend analysis. This will help make the installation process more effective and efficient. Using JMOC/SPOTLITE for training of the JAAR users could expose trends and areas for improving training as the JAAR is fielded and updated. Appendix C has the complete set of measures developed for the JAAR.

The JMOC project accomplished its overall goal of enhancing the use of observer-measures for joint exercises. Establishing a reliable and effective solution to incorporating observer-based measures by integrating existing proven technologies with the Joint After Action Review Repository Library (Riggs & Abbott, 2008) supports not only joint training exercises but any training supported by a JAAR application suite, which will becoming used more widely across services.

## **Discussion**

Given the increasingly complex interactions of systems of systems for training today's military, supporting joint training exercises includes supporting live, virtual and constructive simulations. Capturing and integrating observer-based measures with other data sources is essential for supporting complete assessment of training exercises. The JMOC project successfully integrated proven technology – the SPOTLITE platform for the collection of observer-based measures – into the JAAR. JMOC also provided measures for supporting exercises and to support the JAAR program itself by using observer-based measures to capture

performance on the installation and training for JAAR integrations and deployments. Finally, the efforts of JMOC constitute a foundation for transitioning other measurement technologies into the JAAR.

Results of the JMOC project support several general conclusions. First, development of useful tools for collection of observer-based measures (or, indeed, for other purposes) must be sensitive to a variety of technical and non-technical constraints beyond the basic requirement that it address user needs. Naturally, the technology must be technically compatible with the target environment. In addition, it must be consistent with the organizational and procedural aspects of the target environment – the workflows, standard operating procedures, experience and training of the target users, and the like. The original target group – OTs and OCs – had well-developed paper-based workflows, and was not a suitable target, given the time and resource constraints JMOC faced. With transition to the JAAR, JMOC was able to leverage the considerable organizational and engineering work that had already been done in the JAAR. In addition, the JAAR’s function is to bring technology to bear to support actual exercises, so the JAAR provided a smooth path to using and evaluating JMOC with real end users.

Two kinds of “cultural” obstacles remain, however, for JMOC (or other efforts) to deploy the advances of human performance measurement in an operational training setting. First, the engineering community – as exemplified by the engineers in the JDIF – focuses on engineering details, and is not concerned with issues of measure development and validation. For example, whether JMOC-captured measures are placed in the JAAJ database is an engineering issue, but whether those measures get at important aspects of human performance in training is not. On the other hand, the operational training community – those who design and conduct exercises – will tend to have more appreciation for the measurement issues involved but often lack the time and resources to develop and test measures to ensure that they both address training requirements and have the necessary metric properties. Since JMOC (and much of the rest of the JAAR) can support existing measures, end user measures can usually be incorporated, enabling the measurement technology to be deployed. But – to put it bluntly – if the wrong things were being measured, the technology will still measure the wrong things, and there is a danger that it will even help to perpetuate those measures.

On the other hand, JMOC and related technologies facilitate the incorporation of new measures, and create opportunities for measurement enhancements, since the technologies themselves are not tied to a particular set of measures. Indeed, further JMOC-related activities might well leverage the inroads that the JAAR has made with elements of the operational training community to work with such users on measure development. In addition, a variety of measures have been developed and validated for military training communities across the services and implemented in SPOTLITE, which can be readily used by JMOC users. (Appendix D presents some of these.)

As LVC exercises become more complex, driven both by more complex missions and associated training requirements, and by the increasing complexity of the technologies used by the military for both training and in deployment, the need for richer measures, and better ways to analyze the results of measurement and provide feedback to learners, will only increase.





## References

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## Appendix A: JMOC MAWTS Measures

MAWTS EXCEL Fields	Explanation of Values
DT-WTI Class_Specific	Desert Talon (DT) or Weapons Tactics Instructor (WTI)
Date	
Call Sign	E.G, Latch 67
IP-STUD-Blue-Aug	Instructor Pilot (IP), Student (STUD), Some other, non-MAWTS, aircraft (BLUE), Augment Instructor (Aug)
Name*	Pilot Name
Event	E.G, Offensive Air Support 2 (OAS-2)
FAC Call Sign	or Air Officer (AO)
FAC Inst_STUD	Instructor (Inst), Student (STUD)
T/M/S*	Type/Model/Series of aircraft
BUNO#*	Bureau number of aircraft
# CREW	in aircraft
Range	E.G., Yodaville. Range at Yuma where the event is being held.
Weapon Specific	E.G., 25mm
Weapon General	E.G., guns
Lasing_source	E.G., Ground Lase
Lasing C-D	Continuous (C); Discontinuous (D)
FAC	E.G., FAC-A (airborne FAC)
Coord	Who provides coordination
Release	Y/N--was the weapon released?
POA-POI (m)	Point of Aim/Point of Impact--how far did the weapon land from the target?
Function	
AH Dist To TGT	
AH Miss	
AH LOAL LOBL	
AH Pilot Missile Fired Life	
Primary Reason Code	
Sec_Reason_Code	
2_Primary_Reason_code	
2_Sec_Reason_code	
Other Explanation	
3_cat	

\*Indicates

Highlighted fields: Maj Rascon want the JAAR to capture these values

## Appendix B: JMOC – JAAR Functional Needs Assessment Matrix

Functional Area	Item	SPOTLITE	Voyager Edge	Analyst Toolkit	Description
6.1.1 System Operations Function					<b>The systems operation function contains those needs which pertain to the general operating functions necessary to meet the operational needs environment in which the AAR tool set will perform its functions.</b>
	1	X			The AAR system shall be able to operate in both a fixed and deployable configuration.
	2	X	X		The AAR system shall be modifiable and extensible enabling AAR products to be changed or additional products developed to meet emerging requirements.
	3	X	X		The AAR system shall be an open architecture to permit scalability change, extensibility and capability additions without extensive baseline change.
	5	X			The AAR system shall be expandable and designed to easily incorporate upgrades of capabilities, functions, and technology to support future growth in doctrine, equipment, and training systems.
	6	X			The AAR tool set shall provide modular functions and generic tools configurable for specific applications, to allow flexibility in meeting the needs of diverse groups of users and audiences in different contexts.
	7		X		The AAR tool set shall provide for security up to, and including, the SECRET level. The capability will provide for, and allow, multiple levels of access releasable to coalition and allied forces.
	8	X		X	The AAR tool set shall be required to operate in the windows or windows like operating suite with direct synchronization to Word, Excel, PowerPoint, Access, Outlook, etc.
	9	X		X	The AAR tool set shall be required to use a "flash card" type capability to back up and store all the collected data and have the ability to be declassified through a series of simple procedures.
	10	X		X	The AAR tool set shall be required to allow users to create customized tables and forms and to upload data collected to a database running on a desktop PC or server system and use those databases to generate reports of preliminary findings and integrate with other software to provide readily available reports.
	11	X		X	The AAR tool set shall be required to provide for strategic, operational and tactical analysis.
	12	X			The AAR tool set shall be required to support multiple levels of fidelity, from the Combatant Commander to the individual entity in a tactical situation.
	13	X			The AAR tool set shall be required to support all levels of fidelity, from the task group to the individual war fighter in an urban operations situation.
	14	X	X	X	The AAR tool set shall be required to run on the JTEN and the training equipments used for the event.
	15	X	X		The AAR tool set shall provide for multi-level security and access control.
	16	X		X	The AAR tool set shall provide feedback to a detailed fidelity at the individual, company and/or battalion level.
	17	X		X	The AAR tool set shall provide complete after action review for the total training environment, including all entities, be it live, virtual or constructive.
	18	X		X	The AAR tool set shall be used subsequent to local AAR reviews at each of the sites that participated in the event.
	19		X		The AAR tool set shall be a distributed system providing data, information and knowledge across the JTEN network.
	23				The AAR tool set shall integrate various tools so that raw performance data can be automatically transformed into a finished AAR knowledge or information product.

Functional Area	Item	SPOTLITE	Voyager Edge	Analyst Toolkit	Description
	24	X	X	X	The AAR tool set shall perform user authentication for its clients.
	25	X		X	The AAR tool set shall provide capabilities for developing and distributing team measurement tools, diagnostic assessments, and after action review.
	26	X		X	The AAR tool set shall provide database capabilities for storage and use of historical performance data collected during scenario runs.
	27	X			The AAR tool set shall have the capability to collect data, information and knowledge from service specific AAR tool sets.
	28	X		X	The AAR tool set shall maximize utilization of information or knowledge derived from service AAR tool sets to build the joint perspective.
	29	X	X	X	The AAR tool set shall be utilized for joint training exercises including experiments and demonstrations of new capabilities in a joint environment.
	30	X		X	The AAR tool set is required to provide the functionality to accomplish total mission diagnostic evaluation supporting data, information and knowledge.
					<b>The operator interface function defines the needs for the human to machine interface with the AAR tool set. The general need is to provide data, information or knowledge to the operators in near real time, or post event at multiple locations concurrently. There is the need for specific information at real time, near real time and post mission for the operators and the training audience to work autonomously or in collaboration.</b>
	1	X		X	The operator interface function shall provide an interface to multiple operators at multiple sites.
	3	X			The operator interface function shall provide for the ability to use Personal Digital Assistants (PDAs) to input non-electronic data and observer comments.
6.1.2 Operator Interface Function	4	X		X	The operator interface function shall be capable of uploading JTA observer measures to any PDA for use during the event.
	5	X		X	The operator interface function shall allow for any observer to input or modify/create measures on the PDA.
	6	X		X	The operator interface function shall have a Windows look and feel is user-friendly, providing drop-down menus and familiar human-machine interfaces.
	8	X		X	The operator interface function shall provide screen configurations tailorable for varied operating locations, facilities, and audiences.
	26			X	The operator interface function shall be able to display tabular reports containing processed data from the data repository.
	28	X		X	The operator interface function provide for automatic alerts/notifications of scenario anomalies, instrumentation failures, and digital communication failures at their occurrence.
	29	X		X	The operator interface function shall provide the operator with the necessary status and controls to monitor the conduct of the event.
					<b>The planning function fulfills the needs to provide the analysts and training audience the opportunity to preset certain parameters for measurement, the configuration of the system for the event and the real time needs that are necessary as feedback to the operators for decision making on the event as it unfolds. The definition of the Joint Task Articles to be executed will provide for the data needs by the AAR tool set to provide the operators AAR summary reports at the conclusion of the event.</b>
	15	X			The planning function shall provide all data and information for recording.
	16	X		X	The planning function shall allow for the retrieval of lessons learned information from the JNTC libraries.
6.1.3 Planning Function					

Functional Area	Item	SPOTLITE	Voyager Edge	Analyst Toolkit	Description
<b>6.1.4 Data Retrieval Function</b>					<b>The data retrieval function shall provide the necessary processing to meet the needs of obtaining reference data base information from various sources, obtain the local Service AAR information or knowledge outputs, receive distributed joint AAR data, information or knowledge, and provide for the filtering of irrelevant data.</b>
	1				The data retrieval function shall be able to access databases at a rate sufficient to support all aspects of the AAR functions. Examples of the databases which should be accessible include, but are not limited to, the following:
				X	b. Intelligence Databases
	5			X	The data retrieval function shall be able to produce meta-data, or metric information, for all received or fused files.
	9			X	The data retrieval function shall be able to establish filters to define selected data for inclusion or exclusion.
	10			X	The data retrieval function shall be able to retrieve archived data based on established parameters.
	11			X	The data retrieval function shall be able to access multiple databases.
	15			X	The data retrieval function shall have the capability to reference and communicate with various local Service AAR systems for specific data retrieval.
	16			X	The data retrieval function shall have the capability to retrieve data from the joint distributed AAR data base.
<b>6.1.5 Data Fusion Function</b>					<b>The data fusion function fulfills the need to provide data base linkages for relevance of data units comprising the same entity or action. The fusion function may be viewed as a reference table function allowing the collection of information on one entity from several sources such as, voice, video, imagery, and data links.</b>
	1	U			The data fusion function shall fuse the conclusions from existing Service AAR tools to create a Joint task completion as related to the Joint task
	3	X			The data fusion function shall provide an Event Timeline (any number of events can be added).
	4	X			The data fusion function shall provide a capability to consolidate virtual and constructive with live range instrumentation data.
<b>6.1.6 Data/Knowledge Distribution Function</b>					<b>The data/knowledge distribution function fulfills the needs of the training audience by providing the right information to the right people at the right time. The AAR knowledge network combines repositories of information with methods to organize, search, retrieve, share, and update the information in the repositories. It provides a common interface to knowledge that may be contained in multiple systems and stored in a variety of formats. The KN must include sophisticated methods for retrieving useful information in a usable format. It must support collaboration among people using different and perhaps incompatible information platforms. Finally, it must support dissemination of information as well as retrieval. The AAR KN will provide user-friendly access to vast repositories of existing information (and data) for the training audience and the forces being trained. They will make it possible to query and search these sources in a timely and efficient manner and to rank and present the most relevant results to the user. Figure three illustrates the conceptual need that this function will fulfill.</b>
	1	X			The data distribution function shall be available wherever a JTEN network node is available.
	2	X			The data distribution function shall be able to archive local AAR incoming data files.
	3	X			The data distribution function shall be able to archive all processed or fused, analyzed, or MOP/MOE data.
	4	X	X	X	The data distribution function shall be able to archive and distribute knowledge both in real and non-real time. The real time data will be of specific categories for exercise feedback for the control of the event and for real time casualty assessment.

Functional Area	Item	SPOTLITE	Voyager Edge	Analyst Toolkit	Description
	5		X		The data distribution function shall continuously construct a distributed joint data/knowledge database derived from the fused information.
	8				The data distribution function shall provide for a distributed knowledge network that will allow for searches stimulated by the operator or automatically by an analysis or collaboration task.
	13	X	X	X	The data distribution function shall provide for personal messages.
	14	X			The data distribution function shall provide for system file import/export to allow documents to be brought into the network easily.
<b>6.1.7 Analysis Function</b>					<b>The analysis function will provide the functional capabilities to fulfill the conduct of detailed analysis of sequence of actions, sequence of events, performance of systems or subsystems, strategic, operational or tactical communications performance and COP commonality and distribution.</b>
	2	X		X	The detailed analysis function shall have the capability to determine root cause analysis of training event anomalies.
	6			X	The detailed analysis function shall have the capability to determine training event anomaly root cause identification. The planned scenario versus the actual event conduct shall provide the information to derive anomaly identification.
	8			X	The detailed analysis function shall perform a detailed after-action analysis of the mission's kill chain.
	9			X	The detailed analysis function shall be used to resolve situational awareness discrepancies.
<b>6.1.8 Measures of Performance (MOP)/Measures of Effectiveness (MOE) Function</b>					<b>The MOP/MOE function shall provide the capability to provide subjective and objective information leading to the assessment of team performance during the conduct of a joint training event. The MOP and MOE data definitions and coefficients shall be preset into the AAR tool set during the planning function phase.</b>
Supports	10	X			The MOE/MOP function shall have the capability to derive training effectiveness measures, based upon the execution of the training event, planned versus executed.
Supports	11	X		X	The MOE/MOP function shall have the capability to derive trend analysis of training effectiveness. The trend analysis shall identify from historical training event measures, gaps in the conduct of the training event.
Supports	12	X		X	The MOE/MOP function shall have the capability to indicate gaps in the performance and measure of the training event.
Supports	13	X		X	The MOE/MOP function shall have the capability to indicate gaps or issues that span the total doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) domain.
<b>6.1.9 Replay Function</b>					<b>The replay function shall fulfill the capability gap needs of conducting joint training audience review of the events actions at the tactical operational or strategic level. Replay may be replay of tactical screen captures, or video from specific sites, or video of a command center. This function allows for the training audience to review specific tasks for assessment of actions taken.</b>
	7	X		X	The replay function shall have the ability to replay Personal Digital Assistants (PDAs) non-electronic data and observer comments.
<b>6.1.10 Reports Function</b>					<b>The reports function shall have the capability to provide summary reports of the events and particular entities by time, space or conditions dictated by operator inputs. Also included are the capabilities to provide situational awareness plots and recordings for future playback at remote sites.</b>
	6				The reports function shall provide tailored products within 10 minutes of exercise completion.
<b>6.1.11 Real Time Feedback Function</b>					<b>The real time training feedback function shall provide an information feedback capability in near real time of the situational awareness of the training grid for status monitoring, for real time casualty assessment as denoted by the controlling operators and general system status of the training event to the operators and</b>

Functional Area	Item	SPOTLITE	Voyager Edge	Analyst Toolkit	Description
					<b>training audience.</b>
	3	X	X	X	The real time training feedback function shall be used for training feedback control; thereby providing a near real time playback capability.
	4	X	X	X	The real time training feedback function shall provide the training control operators with the capability to allow forward adjustment recommendations based on feedback provided.
	5	X			The real time training feedback function shall have the capability to review live fire operations as consummated at a MOUT facility.
	8			X	The real time training feedback function shall provide users the capability to establish filter parameters for delivering real-time event information.
<b>6.1.12 Collaboration Function</b>					<b>The collaboration function shall have the capability to provide multi-site collaboration of the event results at simultaneous sites to critique results obtained.</b>
	4			X	The collaboration function shall have the capability to build one file from separate sources simultaneously.
	9			X	The collaboration function shall allow for modification to stored observer notes as desired.
	12			X	The collaboration function shall provide the operators the ability to access lessons learned from previous training events for analysis and comment.
	17			X	The collaboration function shall provide for the composition of conclusive JTA accomplishments using both subjective information and objective information entered during and post event activities.
	19	X		X	The collaboration function shall provide the users the ability to construct DOTMLPF recommendations.
<b>6.1.13 Communications Function</b>					<b>The communications function shall provide the joint AAR tool set with the ability to receive tactical, operational and strategic information from various voice and data links. The purpose of this function is to process data link data information in the sequence and format of the received data.</b>

## Appendix C: JMOC – JAAR Measurement Set

Prompt	Type
Is time synchronized across all machines?	Yes / No
Is the DCM communicating with the data collectors?	Yes / No
Is the DCM able to create a new event?	Yes / No
Is the DCM able to create a new session?	Yes / No
Is simulation data being collected?	Yes / No
If applicable, which environments are being collected?	Checklist
Which Federated Object Model (FOM) is being used?	Checklist
Is virtual data being collected?	Yes / No
If applicable, which environments are being collected?	Checklist
Is live data being collected?	Yes / No
If applicable, which environments are being collected?	Checklist
Is chat data being collected?	Yes / No
If applicable, which environments are being collected?	Checklist
Is observer data being collected?	Yes / No
If applicable, which environments are being collected?	Checklist
Is data processor cooking data for reports?	Yes / No
Is data analyzer displaying units and actions?	Yes / No
Is data analyzer displaying attributes of units and actions?	Yes / No
Is playback from the data analyzer working?	Yes / No
Is report generation working?	Yes / No
Does the event agent report high interest events?	Yes / No
How effective is the 2D entity display?	Likert Scale
How accurate is the symbology?	Likert Scale
Which data sources (LVC) are correctly identified by the display?	Checklist
How effective is the 3D entity display?	Likert Scale
How accurate is the symbology?	Likert Scale
Which data sources (LVC) are correctly identified by the display?	Checklist
Is playback working for 2D?	Yes / No
Is playback working for 3D?	Yes / No
Is playback synchronization working?	Yes / No
Is movie captured from 2D?	Yes / No
Is movie captured from 3D?	Yes / No
Is presentation author launched?	Yes / No
Are the generated products available in the presentation author?	Yes / No
Is the presentation author auto-insert working?	Yes / No
Which products does the presentation author successfully insert into the presentation?	Checklist
Are you able to burn a CD/DVD?	Yes / No
Is the operator capable of performing a system startup and shutdown?	



Is the operator capable of starting and ending an event?	Yes / No
Is the operator capable of starting and ending a session?	Yes / No
Were the operators able to use the bookmarks?	Yes / No
What map functionality does the operator use?	Checklist
Does the operator understand the use of zones?	Likert Scale
Does the operator understand the use of range rings?	Likert Scale
Does the operator understand how to navigate between multiple sessions within an event?	Yes / No
What tools does the operator use to navigate time?	Checklist
Does the operator understand how to navigate to a specific start/end time period within a session?	Yes / No
Does the operator know how to use the report filter tool?	Yes / No
Is the operator aware of the available reports and do they know what they mean?	Yes / No
Does the operator know how to run the event agent?	Yes / No
Is the user able to generate reports using the High Interest Event (HIE)?	Yes / No
Does the user understand how to do synchronized replay?	Yes / No
Did the JAAR produce accurate reports for the event?	Yes / No
Was the JAAR able to produce movie(s)?	Yes / No
Was the JAAR able to produce PowerPoint presentation(s)?	Yes / No
Was the JAAR able to produce screenshots?	Yes / No
Does the operator know how to capture a snapshot from 2D replay?	Yes / No
Does the operator know how to make a movie from 2D replay?	Yes / No
Does the operator know how to make and retrieve a quick report?	Yes / No

## Appendix D: Available SPOTLITE Dynamic Targeting Cell (DTC) Measures

This Appendix presents some of the measures that have been implemented in SPOTLITE and collected by various user groups to support training assessment. They are presented in XML code, which is readily portable, and runs in SPOTLITE.

These were all developed through an extensive, structured process (called the COMPASS Process, for Competency-based Measures for Performance ASsessment Systems), working with domain experts. Each question is tied to a specific **mission essential competency**, for which **observable behaviors** are defined. When questions are on a Likert Scale, as many of them are, those scales are **anchored by specific examples**.

Similar measures are available for a number of different military operational domains, and are in use across Services.

This is header information saying this is the Dynamic Targeting Cell set of questions.

```
<Module webEnabled="false" appName="DTC" displayGlobalPre="true"
  displayGlobalPost="false" title="DTC" caption="Spotlite (DTC)" subcaption=""
  buttonPanel="true" buttonName="Target"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://schemas.aptima.com/spotlite ..\..\spotlite.xsd"
  xmlns="http://schemas.aptima.com/spotlite">
```

This gives subheads and points to other places in the code and supporting materials, so the questions can be traced back to the original Mission Essential Competencies (MECS) >

```
- <Section name="MECS">
- <Section treeName="Target" default="true">
- <Section name="Identify Target">
- <Section name="PID Status" category="questionGroup">
- <Section>
- <LikertScaleQuestionUnit name="51" showNA="true" showNO="true" keywords="PID
  Status" MEC="19,17">
```

This is the actual text of the question that appears on the screen. Note the XML convention which labels it "Question text," making it relatively easy to find, even in richly indented and complex code.

```
<Question text="Does the Target Duty Officer monitor PID status and updates?" />
```

This gives the labels for the three answers:

```
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
</Labels>
- <Descriptors>
  <Descriptor text="Does not monitor PID status" />
  <Descriptor text="Adequately monitors PID status" />
  <Descriptor text="Always monitors PID status" />
```

In the balance of this Appendix, the XML is heavily edited to show just the question and, sometimes, the answer choices. For many of the questions, only a "yes" or "no" answer is required, making observation and recording relatively straightforward, even in the fast-paced training environment.

< [Question text](#) = "Does the Target Duty Officer coordinate with the targets technician for coordinate mensuration preparation?" />

< [Question text](#) = "Does the DTC confirm that the coordinates are in the correct format (DDD.MM.SS or DDDMM.MMM)?" />

< [Question text](#) = "Does the Target Duty Officer request refinements to target coordinate accuracy when necessary?" />

< [Question text](#) = "Does the DTC validate information prior to making a target promote or nominate recommendation?" />

- < [Labels](#) >

< [Label value](#) = "1" />

< [Label value](#) = "2" />

< [Label value](#) = "3" />

</[Labels](#) >

- < [Descriptors](#) >

< [Descriptor text](#) = "Does not validate information" />

< [Descriptor text](#) = "Validates only critical aspects of information" />

< [Descriptor text](#) = "Fully validates information" />

< [Question text](#) = "Does the DTC check or verify target is not on or in proximity to a target on the NSTL or RTL?" />

< [Question text](#) = "Does the DTC review target data using the appropriate targeting manager?" />

< [Question text](#) = "Does the DTC query if the target's set belongs to another component's AO or another target's set?" />

< [Question text](#) = "Does the DTC acknowledge or review the emerging target tasking?" />

< [Question text](#) = "Does the DTC review the notes within the targeting managers (JADOCS) for appropriate mission details?" />

< [Question text](#) = "Does the Target Duty Officer request refined or missing data as necessary?" />

< [Question text](#) = "Does the Target Duty Officer request corroborating evidence (intelligence fusion)?" />

< [Question text](#) = "Does the Target Duty Officer request additional collection when appropriate?" />

< [Question text](#) = "If yes, from the appropriate person?" />

< [Question text](#) = "Does the DTC place time limits on requested data as appropriate?" />

< [Question text](#) = "If yes, are the time limits appropriate?" />

<Question text="Does the DTC update the targeting manager when required?" />

<Question text="Does the DTC prioritize targets correctly (targeting manager)?" />

<Question text="Does the DTC Chief push tasking to the team based on target perishability?" />

- <Labels>
  - <Label value="1" />
  - <Label value="2" />
  - <Label value="3" />
</Labels>
- <Descriptors>
  - <Descriptor text="Pushes inappropriate tasking" />
  - <Descriptor text="Pushes mixed tasking" />
  - <Descriptor text="Pushes relevant executable tasking" />
</Descriptors>

<Question text="Does the DTC Chief effectively communicate the target perishability to the team (i.e., target timeline estimate)?" />

- <Labels>
  - <Label value="1" />
  - <Label value="2" />
  - <Label value="3" />
</Labels>
- <Descriptors>
  - <Descriptor text="Insufficient communication" />
  - <Descriptor text="Communicates, but with difficulty" />
  - <Descriptor text="Effective communication" />
</Descriptors>

<Question text="Does the DTC monitor the target nominating managers for developing emerging targets?" />

<Question text="Does the DTC Chief communicate the status of emerging targets to affected players (i.e. attack cell, SODO, CCO, Joint Components, etc.)?" />

<Question text="Does the DTC use the correct precision for the specified weapon?" />

<Question text="Does the DTC verify that the coordinates are correctly entered into the targeting manager?" />

<Question text="Does the DTC verify updated coordinates from the SIDO are entered into the targeting manager as soon as available?" />

- <Labels>
  - <Label value="1" />
  - <Label value="2" />
  - <Label value="3" />
</Labels>
- <Descriptors>
  - <Descriptor text="Does not expedite update" />
  - <Descriptor text="Updates without regard to prioritization" />
  - <Descriptor text="Correctly updates as prioritized" />

</Descriptors>

<Question text="Does the Attack Coordinator begin to assemble valid weapon target pairings for potential TST employment?" />

<Question text="Does the DTC advise the appropriate personnel of changes in attack priorities?" />

<Question text="Does the Target Duty Officer correctly employ JMEMS?" />

This is a follow-up question:

<Question text="If no, what were the point(s) of failure?" />

<Question text="Does the Attack Coordinator coordinate with the TDO in determining appropriate munitions?" />

<Question text="Does the Attack Coordinator verify with TDO regarding the correct weapon-target pairing for effects, environment, and threat?" />

<Question text="Does the Target Duty Officer coordinate with the Attack Coordinator regarding the appropriate terminal attack axis, if required?" />

This question has a fairly complex follow-up logic for an answer of "no," making it easy for the observer to refine the nature of the observed error.

</YesNoQuestionUnit>

- <Section name="" category="followUp">

- <Section category="followUp">

- <MultipleOptionQuestionUnit name="329" columns="1" isMutuallyExclusive="false">

<Question text="If no, what was the point(s) of failure?" />

- <Options>

<Option text="JMEMS" />

<Option text="CDE" />

<Option text="Deconfliction" />

<Option text="Airspace" />

<Option text="Threats" />

</Options>

<Question text="Does the DTC prioritize attack options?" />

<Question text="Does the DTC develop a timeline estimate for each attack option?" />

<Question text="Does the DTC revise the attack planning priorities based on timeline constraints?" />

<Question text="Does the Target Duty Officer make a collection request that includes all the pertinent information (EEI, timeline, resolution of image or product, target surveillance)?" />

<Question text="Does the Target Duty Officer coordinate for continued surveillance, if required?" />

< [Question text](#) = "Does the DTC Chief reassess target dynamics adequately enough to maintain situational awareness (SA) on the ability to execute the attack?" />

- < [Labels](#) >
  - < [Label value](#) = "1" />
  - < [Label value](#) = "2" />
  - < [Label value](#) = "3" />
- < /[Labels](#) >
- < [Descriptors](#) >
  - < [Descriptor text](#) = "Does not reassess target dynamics" />
  - < [Descriptor text](#) = "Reassess only critical target dynamics" />
  - < [Descriptor text](#) = "Reassess all target dynamics" />

< [Question text](#) = "Does the DTC coordinate to obtain relevant target characteristics, if they are not available or assumable?" />

- < [Labels](#) >
  - < [Label value](#) = "1" />
  - < [Label value](#) = "2" />
  - < [Label value](#) = "3" />
- < /[Labels](#) >
- < [Descriptors](#) >
  - < [Descriptor text](#) = "Irrelevant data to produce desired effects requested" />
  - < [Descriptor text](#) = "Relevant data to establish probability of desired effects requested" />
  - < [Descriptor text](#) = "Complete data to produce desired effects requested" />
- < /[Descriptors](#) >

< [Question text](#) = "Did the Target Duty Officer coordinate in a timely manner, consistent with target priority and tactical dynamics?" />

< [Question text](#) = "Does the DTC consider non-kinetic solutions?" />

< [Question text](#) = "Does the DTC check or verify target is not on or in proximity to a target on the NSTL or RTL?" />

< [Question text](#) = "Does the DTC check targeting manager (or other approved source, e.g., brief, web page, etc.) for LOAC restrictions?" />

< [Question text](#) = "Does the DTC communicate with SJA for LOAC restrictions if not in targeting manager (or other approved source, e.g., brief, web page, etc.)?" />

< [Question text](#) = "Does the Target Duty Officer collaborate with the Attack Coordinator on proper tier-level processing for CDE?" />

< [Question text](#) = "Does the Target Duty Officer enter the CDE data in the targeting manager?" />

< [Question text](#) = "Does the Target Duty Officer accomplish/coordinate COE, as required?" />

< [Question text](#) = "Does the Attack Coordinator consider all current tactical dynamics (e.g., target type, weather, aircraft location) when developing attack solutions?" />

<Question text="Does the Attack Coordinator consider all new tactical dynamics (e.g., target type, weather, aircraft location) when planning ISR requests for attack support?" />

<Question text="Does the Attack Coordinator select an appropriate attack solution considering current tactical dynamics (e.g., target type, weather, aircraft location)?" />

<Question text="Does the DTC coordinate or review an aircraft/weapons combination that is appropriate for the target given current environment characteristics?" />

<Question text="Does the DTC Chief communicate target priorities based on theater constraints/tactical situation?" />

<Question text="Does the DTC consider attack solutions based on the target defense characteristics?" />

<Question text="Does the DTC review the risk guidance before putting together the strike package?" />

- <Labels>

<Label value="1" />

<Label value="2" />

<Label value="3" />

</Labels>

- <Descriptors>

<Descriptor text="Does not do risk analysis" />

<Descriptor text="Performs an incomplete risk analysis" />

<Descriptor text="Verifies match with higher headquarter guidance" />

</Descriptors>

</LikertScaleQuestionUnit>

<Question text="Does the DTC create acceptable package options based on the risk guidance for the TST and its environment?" />

<Question text="Does the DTC review risk mitigation options (e.g., non-kinetic, stand-off munitions, timing)?" />

<Question text="Does the DTC appropriately coordinate to ensure attack and/or support assets to match attack options with acceptable risk?" />

<Question text="Does the DTC coordinate for target prosecution?" />

<Question text="Does the DTC have systems (e.g., TBMCS, JADOCS, chat, etc.) set up to verify status of all available air assets?" />

<Question text="Does the DTC review scheduled air operations using the most current ATO execution status?" />

- <Labels>

<Label value="1" />

<Label value="2" />

<Label value="3" />

<Label value="4" />

</Labels>

```

- <Descriptors>
  <Descriptor text="Did not review ATO execution" />
  <Descriptor text="Old ATO execution data reviewed" />
  <Descriptor text="Most current ATO execution data reviewed" />
  </Descriptors>

  <Question text="Does the DTC use the appropriate tools to review the current ATO
  execution?" />

  <Question text="Does the DTC coordinate with the ODO/LNOs for scheduled XINT and
  SEAD missions?" />

  <Question text="Does the DTC use a complete and current inventory of available attack
  and support assets for planning?" />

  <Question text="Does the DTC review non-ATO joint attack/support assets when
  appropriate?" />
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
  <Label value="4" />
  </Labels>
- <Descriptors>
  <Descriptor text="No non-ATO assets reviewed" />
  <Descriptor text="Some non-ATO assets reviewed" />
  <Descriptor text="All possible non-ATO assets reviewed" />
  </Descriptors>

  <Question text="Does the DTC include non-ATO joint attack/support assets in the attack
  options when appropriate?" />
  </YesNoQuestionUnit>

  <Question text="Does the DTC coordinate for non-ATO joint attack/support assets?" />

```

Note alternatives for the following question if a "no" is the answer.

```

<Question text="Does the Attack Coordinator recommend appropriate support assets
within an attack solution based on tactical dynamics (e.g., target type, weather,
aircraft location)?" />

  </YesNoQuestionUnit>
- <Section name="" category="followUp">
- <Section category="followUp">
- <MultipleOptionQuestionUnit name="323" columns="1" isMutuallyExclusive="false">
  <Question text="If no appropriate recommendation was made, which tactical dynamics
  were missed?" />
- <Options>
  <Option text="Target type" />
  <Option text="Threats in target area" />
  <Option text="Package time to target" />
  <Option text="Weather" />

```



```

<Option text="Strike/support asset availability" />
<Option text="Weapon effectiveness" />
<Option text="Other" />
</Options>
</MultipleOptionQuestionUnit>
</Section>
</Section>

<Question text="If no appropriate recommendation was made, which support assets
were missed?" />
- <Options>
<Option text="Tanker" />
<Option text="SEAD" />
<Option text="ECM" />
<Option text="Other" />
</Options>
</MultipleOptionQuestionUnit>
</Section>
</Section>
</Section>

<Question text="Does the DTC coordinate with the C2DO to obtain airborne factors
affecting the plan?" />

<Question text="Does the DTC verify SCL or current weapon inventory through
ODO/unit LNO (or C2DO if airborne assets)?" />

<Question text="Does the DTC verify availability of XINT/XSEAD assets on station
with tactical C2 units?" />

<Question text="Does the DTC coordinate with component command element as
appropriate for joint fires or support?" />

<Question text="Does the DTC internally communicate relevant information regarding
coordination with component liaisons for joint fires and support?" />
- <Labels>
<Label value="1" />
<Label value="2" />
<Label value="3" />
</Labels>
- <Descriptors>
<Descriptor text="No relevant information communicated" />
<Descriptor text="Only the most critical information communicated" />
<Descriptor text="All relevant information communicated" />
</Descriptors>

<Question text="Does the DTC consider all critical factors when
assessing/communicating ATO impacts based on prosecuting potential targets?" />

<Question text="Does the DTC Chief's resource management decisions adversely affect
the efficiency/effectiveness of the overall planned ATO?" />

```

<[Question text](#)=**"Does the DTC communicate the impact of TST tasking on the ATO if required?"** />

<[Question text](#)=**"Does the DTC coordinate to ensure that BDA occurs?"** />

<[Question text](#)=**"Does the DTC Chief ask questions of his team concerning the details of the attack plan prior to going to the CCO?"** />

<[Question text](#)=**"Does the DTC Chief communicate the attack plan to the CCO?"** />

<[Question text](#)=**"Does the DTC address the concerns provided by CCO/SODO and replan as required?"** />

<[Question text](#)=**"Does the DTC Chief communicate the revised attack plan to the CCO if required?"** />

<[Question text](#)=**"Does the DTC verify attack complies with PID, CDE, and deconfliction?"** />

</[YesNoQuestionUnit](#)>

- <[Section name](#)=**"**[category](#)**"**=**"followUp"**>
- <[Section category](#)=**"followUp"**>
- <[MultipleOptionQuestionUnit name](#)=**"327"** [columns](#)=**"1"** [isMutuallyExclusive](#)=**"false"**>
- <[Question text](#)=**"If no, what was missed?"** />
- <[Options](#)>
- <[Option text](#)=**"PID"** />
- <[Option text](#)=**"CDE"** />
- <[Option text](#)=**"Deconfliction"** />
- </[Options](#)>
- </[MultipleOptionQuestionUnit](#)>

<[Question text](#)=**"Does the DTC communicate recommendations for attack solutions using the targeting manager?"** />

<[Question text](#)=**"Does the DTC select and communicate an appropriate attack solution or recommend "No-Go"?"** />

<[Question text](#)=**"Does the DTC Chief ask for final approval for TST/CPT tasking from required higher authority (CCO, SODO) if required?"** />

<[Question text](#)=**"Did the DTC coordinate to validate correct TST/CPT mission tasking (i.e., investigate, target, destroy)?"** />

<[Question text](#)=**"Does the DTC confirm the AO owner for battlespace deconfliction?"** />

<[Question text](#)=**"Does the DTC coordinate with component command elements for deconfliction as required?"** />

<[Question text](#)=**"Does the DTC ensure appropriate airspace control measures are planned and communicated to Airspace Management?"** />

<[Question text](#)=**"Does the DTC input TST/CPT mission tasking (i.e., investigate, target, destroy) into the targeting manager?"** />

<Question text="Does the DTC prepare the tasking message?" />

<Question text="Does the DTC Chief coordinate to ensure that the team is appropriately monitoring mission execution?" />

<Question text="Does the DTC choose the appropriate tools for monitoring mission execution?" />

Here we see both choice options and follow-ups to some of those answers, getting into actionable detail.

<Question text="Does the DTC coordinate internally and with external personnel (i.e., CCO, SODO, SIDO, Plans) with regard to mission execution?" />

- <Labels>

<Label value="1" />

<Label value="2" />

<Label value="3" />

<Label value="4" />

</Labels>

- <Descriptors>

<Descriptor text="Does not coordinate with any appropriate personnel" />

<Descriptor text="Coordinates only with critical personnel" />

<Descriptor text="Coordinates with all appropriate personnel" />

</Descriptors>

</LikertScaleQuestionUnit>

- <Section name="" category="followUp">

<Section category="followUp">

- <VipersQuestionUnit name="228" MEC="17,22,20" showCGI="false">

<Question text="" />

- <Options>

<Option text="DTC Chief" />

<Option text="AC" />

<Option text="TDO" />

</Options>

</VipersQuestionUnit>

</Section>

</Section>

</Section>

- <Section>

<Question text="Does the DTC maintain situation awareness (SA) using the appropriate displays and tools to determine mission result?" />

<Question text="Does the DTC review, assess, assimilate, and act on INFLTREP when available to establish follow-on actions?" />

<Question text="Does the DTC request mission results updates from the C2DO if TOT has expired and no mission results were reported?" />

- <Options>

<Option text="Was the timeliness of the request appropriate given the situation?" />

```

<Option text="Was the completeness of the request appropriate given the situation?"
/>

<Question text="Does the DTC verify/review BDA in appropriate targeting manager as
necessary?" />
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
  <Label value="4" />
  </Labels>
- <Descriptors>
  <Descriptor text="BDA not verified/reviewed" />
  <Descriptor text="Only critical BDA aspects verified/reviewed" />
  <Descriptor text="BDA verified/reviewed completely" />
  </Descriptors>

<Question text="Does the DTC ensure that the TST/CPT mission BDA is entered into the
targeting manager?" />

<Question text="Does the Target Duty Officer follow-up with additional intelligence
sources/products to corroborate BDA as appropriate?" />

<Question text="Does the DTC attempt to expedite closure of assessment post-strike?"
/>

<Question text="Does the DTC Chief check the targeting manager for currency of
mission status?" />

<Question text="Does the DTC coordinate on the mission results to decide on future
actions (i.e., request additional intelligence, mission complete, re-strike, pass to
Plans)?" />

<Question text="Does the DTC close out actions on target appropriately once
assessment is completed?" />

<Question text="Does the DTC correctly communicate actual assets used versus planned
assets to the appropriate personnel (SODO, ODOs, Plans, etc.)?" />

<Question text="Does the DTC review updates to relevant guidance (e.g., documents,
messages, verbal, chat, tables, AOD, MAAP brief, Commander's guidance)?" />
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
  <Label value="4" />
  </Labels>
- <Descriptors>
  <Descriptor text="No relevant guidance reviewed" />
  <Descriptor text="Only critical guidance reviewed" />
  <Descriptor text="All relevant guidance reviewed" />
  </Descriptors>

```

```

<Question text="Does the DTC Chief make the DTC team aware of updates?" />
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
  <Label value="4" />
  </Labels>
- <Descriptors>
  <Descriptor text="Never" />
  <Descriptor text="Sometimes" />
  <Descriptor text="Always" />
  </Descriptors>
  </LikertScaleQuestionUnit>
- <Section name="" category="followUp">
- <Section category="followUp">
- <MultipleYesNoQuestionUnit name="7" showNA="true" showNO="true" columns="1">
  <Question text="Updates to:" />
- <Options>
  <Option text="SPINS" />
  <Option text="ROE" />
  <Option text="No Strike and Restricted Target List" />
  <Option text="Weather" />
  <Option text="TST Matrix" />
  <Option text="Other updates" />
  </Options>
  </MultipleYesNoQuestionUnit>
  </Section>
  </Section>
  </Section>
- <Section>

<Question text="Does the DTC request further
guidance as appropriate?" />

<Question text="Does the DTC Chief present complete and accurate information
regarding guidance changes to the team?" />

<Question text="Does the DTC Chief ensure that the team understands each of their
roles and responsibilities in the dynamic targeting process?" />
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
  <Label value="4" />
  </Labels>
- <Descriptors>
  <Descriptor text="Assumes team understands with no verification or pre-brief" />
  <Descriptor text="Questions team members only on critical aspects of dynamic
targeting" />
  <Descriptor text="Proactively establishes roles and responsibilities with pre-brief and
verbal assessment" />

```

```
</Descriptors>
</LikertScaleQuestionUnit>
</Section>
```

```
<Question text="Does the DTC have all applications and resources open and/or
available for efficient retrieval of critical information?" />
```

```
- <Labels>
  <Label value="1" />
  <Label value="2" />
  <Label value="3" />
  <Label value="4" />
</Labels>
- <Descriptors>
  <Descriptor text="None open and/or available" />
  <Descriptor text="Critical apps/resources open and/or available" />
  <Descriptor text="All relevant apps/resources open and/or available" />
</Descriptors>
</LikertScaleQuestionUnit>
- <Section name="" category="followUp">
- <Section category="followUp">
- <MultipleOptionQuestionUnit name="18" columns="1" isMutuallyExclusive="false">
  <Question text="Which applications or resources were not open and/or available?" />
- <Options>
  <Option text="Chat windows" />
  <Option text="COP" />
  <Option text="Targeting manager" />
  <Option text="CDE Tool(s)" />
  <Option text="Target manager" />
  <Option text="Current ATO ISR asset availability" />
  <Option text="Current SITREP for Area of Responsibility" />
  <Option text="Current ATO Attack asset availability" />
  <Option text="Weapons/Target pairing guidance" />
</Options>
```

```
<Question text="Does the DTC review and/or refresh relevant applications when
appropriate?" />
```

```
<Question text="Does the Attack Coordinator select the appropriate common operating
picture?" />
```

```
<Question text="Is the Attack Coordinator aware of current IPB/Intel situation?" />
```

```
<Question text="Does the DTC communicate with personnel when there are information
shortfalls and/or needs?" />
```

```
<Question text="Does the DTC up-channel chronic resource shortfalls to the appropriate
personnel?" />
```

```
<Question text="Does the Target Duty Officer up-channel collection request shortfalls?"
/>
```

<[Question text](#)= "**Does the DTC populate collaboration tools:**" />

<[Question text](#)= "**Does the DTC prioritize workload in a manner that can acknowledge new emerging targets?**" />

<[Question text](#)= "**In the event of a communication failure, does the DTC use the appropriate backup systems?**" />

## **Appendix E: Summary of Digital Pen/Paper Technologies**

Digital Pen and Paper technology has been available commercially for about five years. While the technology continues to advance it has not made the significant breakthrough that has allowed it to make large in-roads into everyday use. The problem lies with the technology and the current solutions. The basic approach behind digital pen technology is to track the position of the pens tip and then store the coordinates as a digital file. The digital file is then interpreted and processed through optical character recognition (OCR) software once the files have been transferred to a standard computer. Transfer is done via a universal serial bus (USB). In order to track the pens location and establish the reference points necessary to plot and record the pens movements three different techniques are currently being employed:

1. Digital Pen with special paper
2. Digital Pen with special transceiver
3. Digital Pen with transceiver tablet

### **1. Digital pen with special paper**

The technique used here is to have either dots or a grid printed on paper that the pen can reference to help determine its location. In most instances the dots are printed on plain paper so the cost of the paper is minimal although the purchase of this pre-printed paper becomes a necessary adjunct to the use of the pen. One manufacturer provides a portable data file formatted (PDF) file containing the necessary dots so that the user has the option of printing their own paper. The pen with pre-printed paper appears to be the most popular technique and the paper now has a technical specification and is referred to as Anoto Paper or Anoto Technology. Many of the major paper manufactures – including 3M, Franklin Covey, and Oxford – now produce Anoto paper. ([www.anoto.com](http://www.anoto.com)).

Pens using this technology include:

- Logitech io2 (purchased for testing)
- Nokia SU-1B
- Magicomm G303
- Maxell Penit Digital Pen (appears to be pen used by Magicomm above)
- Sony Ericsson Chatpen CHA-30

### **2. Digital Pen with special transceiver**

In an attempt to free the digital pen from requiring special paper or a special tablet a few companies have developed a special transceiver device that can be clipped to the paper or clipboard the paper is being used on. This transceiver then communicates with the pen and tracks the pen's position and records the data in the transceiver. The data is then transferred from the transceiver to a computer via USB. The advantage of this approach is the freedom to use it anywhere with no special paper or tablet. The disadvantage is that there can be interference between the pen and the transceiver especially by left-handed writers whose tendency to curl their hands above the pen often blocks or interferes with the transmission.



From reviews it appears that this approach is not as accurate as the pen and paper approach. Pens using this technology are:

- Pegasus Mobile NoteTaker
- EPOS Digital Pen

### 3. **Digital Pen with transceiver tablet**

In this approach the pen transmits its location to the tablet which records the data. The data is then transferred from the tablet to a personal computer (PC). An advantage of this approach is that no special paper is required and the tablet/pen combination should theoretically be the most accurate. The disadvantage is the need to use and transport the supplied tablet. Reviews of the current products using this technique tend to indicate that the construction of the products is on the flimsy side.

Pens using this technology:

- ACECAD DigiMemo
- Adesso Cyberpad (purchased for testing)

#### *Summary of Reviewed Software*

Almost all of the hardware manufactures above rely on third party software for the OCR translation of their handwriting captures. The one exception is Logitech, which provides its own software but is also compatible with MyScript Notes.

1. MyScript Notes: This appears to be the leading handwriting recognition software and is compatible with most products listed above.
2. EverNote ritePen: This is another handwriting recognition software application that is compatible with many of the products above. It does not appear to be as highly rated nor as extensible as MyScript
3. CalliGrapher (for pocket PCs): This is the leading handwriting recognition software for Pocket PCs.

#### *Summary of Digital Pen Technologies*

Advantages:

1. This method allows the transference of the observers' input into digital format with the least effort.
2. It provides the most familiar solution as it basically allows the observers to continue with their current method of using hand writing as an input source.

Disadvantages

1. It does not allow for any feedback on the ability of the software to decipher and translate the input text. In some instances the translations might not work well and manual input of the data may be required. Since all pen data is in essence backed up by a hard copy paper version this is not necessarily a major issue although the use of some personnel for review/cleanup as well as auxiliary entry may be required.
2. It does not allow the observer to receive any guidance or feedback. This is basically a one way procedure from the observers to the computer system with no opportunity for any guidance, feedback or auxiliary information to be provided by the computer system.
3. Data must be transferred into the system. While a pocket PC or tablet PC can be set up to directly transfer data into the computer system with the proper tags, data captured and then translated into the system will still need to be added to the database.