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Battlespace Situational Awareness and Layered Sensing

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14. ABSTRACT

This report summarizes the Battlespace Situational Awareness and Layered Sensing concepts. The concepts produce a scenario of new capabilities that would enhance the Air Force-Distributed Common Ground System (AF-DCGS) – the AN/GSQ-272 SENTINEL weapon system. The use of dynamic re-tasking capabilities and the Layered Sensing attributes were combined to demonstrate new capabilities to the Warfighter.

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PREFACE

This effort was conducted by the Anticipate and Influence Behavior Division, Behavior Modeling Branch, Human Effectiveness Directorate, 711th Human Performance Wing of the Air Force Research Laboratory (711 HPW/RHXB), Wright-Patterson Air Force Base, Ohio, under the Work Unit 7184X06C. It was supported by SRA International, Inc., C4ISR Center, Dayton, Ohio, under Contract FA8650-04-D-6405, Task Order 0003. Mr. Gilbert Kuperman was the Air Force Project Manager for this effort.

The goal of the Shared Battlespace Awareness project was to develop and demonstrate the conceptual Situational Awareness (SA) displays that can assist decision makers within the Combined Air Operations Center (CAOC). The conceptual displays were developed to support ISR collection plan execution monitoring, adjustment, and re-tasking. The intent of the displays is to promote collaboration between the CAOC Divisions to support dynamic Intelligence, Surveillance, and Reconnaissance (ISR) management.

The result of the effort was a conceptual demonstration of human-system interface (HSI) concepts that are intended to dramatically increase situational awareness and decision support for the dynamic control of ISR assets, improve insight into the impact of sensor re-tasking on current ISR collection execution, and provide CAOC operators with a common tool to support unplanned collection requirements. The effort also provided a new dynamic ISR management process, leading to the identification and analysis of recommended improvements.

Special thanks to all the individuals who supported this effort including: Mr. Craig Stansifer (AFRL/RHXC), Mr. Jeff Cress, Mr. Kerry Taylor, Mr. Scott Macbeth, Mr. David Klinger, Mr. Orion “Gonzo” Gonzalez, Mr. Doug Chapman, Mr. Pat Ryan, Mr. Dave Freeman, and Ms. Jennifer Thieke (SRA International, Inc.).

1.0 SUMMARY

The Behavior Modeling Branch of the Anticipate and Influence Behavior Division, 711 Human Performance Wing (711 HPW/RHXB) of the Air Force Research Laboratory (AFRL) initiated an exploratory effort directed at better understanding the need to improve current Intelligence, Surveillance, and Reconnaissance (ISR) planning and management capabilities. The goal was to improve the dynamic management of ISR assets through enhanced Situation Awareness (SA). Using Mica Endsley's SA model of *perception, comprehension, and projection,*[1] improving SA for dynamic Intelligence, Surveillance, Reconnaissance (ISR) management begins with the perception of the current state of ISR assets, continues to comprehension of how current collection requirements are being met, and supports the projection of what the future collection needs will be and how they will be attained.

A primary source of decision aiding for ISR management and re-tasking is the ISR Synchronization Matrix. The "Synch" Matrix is a static, tabular schedule established prior to the Air Tasking Order (ATO) execution depicting when ISR assets are scheduled to be in theater. Changes to collection schedules that occur after the matrix is developed are not reflected in a real-time display. This lack of real-time asset status leads to additional communication burden, mental calculations, and increased cognitive workload for individuals in the ISR and Combat Operations Divisions (ISRD & COD) within the Combined Air and Space Operations Center (CAOC).

The end goal of the "Shared Battlespace Awareness and Decision Aiding Displays for ISR Re-planning" project was to demonstrate a shared situational awareness display for the execution and dynamic management of the Joint Prioritized Collection List both within and between the ISRD and COD of the CAOC. The goals were also to present decision centric displays that accurately reflects operational context and demonstrates how the shared situational awareness display addresses dynamic ISR management capability shortfalls.

The Sensors Directorate of AFRL (AFRL/RY) is currently pursuing a Layered Sensing (LS) concept to address the need to make information more readily available to warfighters. LS has twelve attributes that are to be woven together to ultimately achieve the goal of enhancing operational effectiveness. This report will show the tie between the exploratory 711 HPW/RHXB's Shared Battlespace Awareness effort and the LS concept that was promulgated by AFRL/RY. The need for a dynamic ISR re-tasking tool is presented here, showing the concept's contribution within the LS construct.

2.0 INTRODUCTION

This section provides an overview of the Shared Battlespace Awareness concept as well as of the Layered Sensing (LS) concept.

2.1 Shared Battlespace Awareness

The goal of the Shared Battlespace Awareness project was to develop and demonstrate the conceptual Situational Awareness (SA) displays that can assist decision makers within the ISRD and COD of the CAOC. The conceptual displays were developed to support ISR collection plan execution monitoring, adjustment, and re-tasking. The displays provided collaboration between the two CAOC Divisions to support dynamic ISR management.

The result of the effort was a conceptual demonstration of human-system interface (HSI) concepts that are intended to: improve situational awareness and decision support for the dynamic control of ISR assets, improve insight into the impact on current ISR collection execution of sensor re-tasking, and provide a common tool for CAOC operators to support unplanned collection requirements. The concept also provided a new dynamic ISR management process, leading to the identification and analysis of recommended improvements.

2.2 Layered Sensing

The LS concept is part of the AFRL/RY's approach to making critical information readily available to warfighters. AFRL/RY describes LS in the following manner:

> "Layered Sensing provides military security decision makers at all levels with timely, actionable, trusted, and relevant information necessary for situational awareness to ensure their decisions achieve the desired military/humanitarian effects. Layered Sensing is characterized by the appropriate sensor or combination of sensors/platforms, infrastructure and exploitation capabilities to generate that SA and directly support delivery of 'tailored effect'."[2]

Execution of the Layered Sensing concept is expected to contribute significantly to warfighter capabilities in fighting future conventional and unconventional wars.

The LS concept provides customers with actionable information, without the need for expensive or unobtainable tools and data. LS is defined by 12 attributes that, when combined will result in the enhancement of operational effectiveness (Table 1).

Table 1: Attributes of Layered Sensing

Persistent Coverage	Wide Area Coverage	Assured Global Access
Engagement Quality Information	Timeliness	Trusted Sensing
Information Triage	Robust, Agile and Adaptable	Spectrum Dominance and Control
Affordable Open System Architecture	Anticipatory Observations and Interactive Engagements	Tailored Performance

Defining the attributes assists the development of the concept and brings multiple directorates of AFRL together for further evolution of LS. Having 12 specific attributes allows other AFRL directorates to easily adapt programs within their purview, supporting the LS concept. Each attribute suggests a type of domain where further development of technologies and ideas can take place to mature the LS concept and Air Force ISR capabilities. As envisioned, mature LS attribute domain technologies will produce tailored effects and tailored situational awareness tools for decision makers. When the tool settings are customized to match the operational context, the tools will seamlessly integrate to acquire, sort, and prioritize data prior to displaying that information to decision makers. This will enhance situational awareness, thus supporting the decision making process.

2.3 Interpretation of Layered Sensing

An operational approach to the LS concept is to interpret it through the overarching needs of the decision maker. Warfighter/decision makers need timely, accurate, and relevant information tailored to their mission. Information, as opposed to data or "raw" imagery, is produced through analytic processes. The current lack of available information systems prevents sufficient information sharing between analysts and warfighters to answer all questions. Essential Elements of Information (EEIs) provide analysts guidance with what information is needed from the imagery. Unfortunately, EEIs are often very general and provide the analysts little direction. Despite these inherent shortcomings, if the analysts know who is asking the questions and how the information will be used, they could gather more relevant and useful information. Often, necessary information exists within the collected intelligence, but is not available to decision makers because the right questions were not asked to the analysts. Adhering to LS principles and emphasizing certain LS attributes provides a means for the analyst to access previously unavailable information and provide better solutions to Warfighters.

Achieving the LS attributes will potentially fill information gaps and aid analysts and decision makers. An example of an LS attribute is Assured Global Access. Analysts around the globe need access to information. Assured Global Access provides analysts with access to necessary domains through net-centricity[3], regardless of their location. This access to previously unavailable information enables the analyst to perform a more thorough (both broader and deeper) review of relevant data, thereby allowing them to make better recommendations to decision makers. Similar capability enhancements are expected to be achieved within the other 11 LS attributes.

2.4 Purpose of Report

The purpose of this report is to identify and describe the utilization of the Shared Battlespace Awareness and Decision Aiding Displays for ISR Re-planning (from this point on referred to as the Dynamic Re-tasking Tool [DRT]) and the LS concept in "real world" scenarios. Though the LS concept extends beyond military use, this report focuses on United States Air Force uses both in the near term and for future applications. We describe a scenario involving the Air Force Distributed Common Ground System (AF-DCGS)[4] and demonstrate the manner in which LS concept could enhance the capabilities of the AF-DCGS in various joint operations.[5]

For the Layered Sensing concept to be useful to other AFRL directorates, as well as other agencies, it is useful to couple the concept with realistic scenarios. This approach provides much needed context to frame the development of domain technologies.

This report was developed by subject matter experts (SMEs) with experience in operational settings, and engineers with extensive understanding of operational capabilities. The situations and topics explained are based on the author's experiences while working in the AF-DCGS and other programs. All observations are based on experiences and studies. The authors will explore implications of the LS concept with use of the DRT while also suggesting opportunities for improving the broader ISR process. By making a few changes to the AF-DCGS process, these concepts suggest how the DRT and the LS concept can improve operations. For example, the introduction of an "Intelligence Wingman (IW)" position (to directly support the warfighters of the AF-DCGS) is an operational change that implements several LS attributes. Currently, the analysts in the AF-DCGS relay information to their customers mostly through the Liaison Officers (LNOs). The analysts are not in direct communication with the end users of the products. Furthermore, the addition of the DRT to aid communication among the IW, AF-DCGS analysts, other remotely located analysts (i.e., CAOC Analysis, Correlation, and Fusion [ACF] Cell), and the end-user of the analysis is another operational change that may further demonstrate the potential value of the DRT and LS concepts.

2.5 Current Operational Observations

This section will show some of the shortfalls in current operations based on operators' personal experiences, studies of operations from other perspectives, and SMEs' understandings of current Tactics, Techniques, and Procedures (TTPs) and other doctrine. This section is not meant to discount the hard work that the men and women of the United States military perform. The intent is to suggest additional methods that will aid the warfighter in the decision making process.

Currently, several military operations are taking place that highlight the difficulty analysts and decision makers face when identifying the enemy during irregular warfare[6]. Trend identification and forensic analysis techniques exist that, combined with other analytic methods, can assist in identifying the enemy and revealing the enemy's location. Sensors collecting data for one agency may provide useful intelligence to another but the lack of communication among groups prevents full exploitation[7]. This lack of shared knowledge impedes analysts and decision makers and puts the lives of US warfighters at risk.

In this effort we focus on some information access and information sharing problems in the AF-DCGS. An AF-DCGS includes analysts in several intelligence specialties accessing intelligence feeds from various platforms and sensors. For example, analysts at a Distributed Ground System (DGS), the ground station within the AF-DCGS enterprise where the analysis takes place, may support the same platforms and sensors that other analysts support, while potentially addressing very different customer requirements.

Another problem faced in the current AF-DCGS is that analysts often have very little understanding of the operations they support. They may also lack insight into how their reports and analysis are used. For example, a battlefield commander may need information about a certain area in order to gain situational awareness. The commander has his personnel issue a Request for Information (RFI) to find out as much as possible about the area of interest. The CAOC, ISRD receives the RFI, tries to match it with current information, and then, through several channels, tasks a DGS with EEIs to collect imagery and intelligence on the area.[8] An EEI that a first phase analyst may receive reads, "*Report any significant information observations in the area*." While that tells the analyst in very general terms what needs to be done, the analyst still lacks the context or understanding of the value of different types of information. More guidance from, and direct interaction with, the "end users" may well enhance the reports from analysts.

Beginning in the summer of 2007, the AF-DCGS made changes to help aid analysts and customers. They implemented a DCGS Analysis and Reporting Team (DART)[9] composed of a mix of AF intelligence specialties. DART analysts work with customers to ensure availability of data and to answer any questions. The DART provides an excellent mechanism to explore the implementation of LS concepts in a real world environment. *(Throughout this report, we try to work within the existing DCGS and DART framework and any assumptions made about future capabilities are clearly marked as hypothetical.)*

3.0 METHODS, ASSUMPTIONS AND PROCEDURES

This section includes a discussion of potential future applications of LS and an illustrative scenario.

3.1 Layered Sensing in the Future

Opportunities exist to implement LS attributes in future military operations, both in the short-term and the long-term. With a combined effort on the part of technologists, analysts, and decision makers, today's technologies can efficiently bring LS attributes into the current operational environment. The end-state of this effort would be to provide tailored SA through net-centricity. An example of tailored situational awareness is the combination of Persistent Coverage and Assured Global Access. Pairing these attributes brings together different arrays of sensors allowing analysts to observe more events in their area of interest. When sensors are on target (Persistent Coverage), but information sharing is lacking, global access is not achieved. With Assured Global Access sharing, combining these pieces of the puzzle allows for better and more thorough analysis and provides analysts with the information they need to answer their customer's questions.

Another example of bringing attributes together is Wide Area Coverage. Currently operational sensors and those being developed and demonstrated collect data on larger areas, often with higher resolutions than previous systems provided. With the additional coverage, adding Persistent Coverage to the Wide Area enhances intelligence gathering, thereby providing more areas to analyze. These two capabilities together allow the analysts to make improved assessments and to better assist their customers.

Other technologies could further aid Wide Area Coverage and possibly other LS attributes. Assisted Target Recognition (ATR) is a highly researched field.[10] While there is more research to be conducted in ATR, there have already been some successes. Those successes include cueing systems that algorithmically select which targets to chip out of an image and send to analysts for human-in-the-loop identification. Identifying targets with high reliability and few "false alarms" is a difficult task for ATR systems. However, sending chipped targets to analysts allows analysts to accelerate reports, thereby aiding the *Timeliness* attribute of LS. Certainly, ATR requires more study, but it stands as an example of how to bring an LS attribute into the real-time operating environment.

The LS attribute, *Engagement Quality Information*, needs to be implemented quickly. If analysts knew how valuable their information was to a decision maker they would have a greater stake in the analysis they were performing. Analysts are trained to, and always perform at, a professional level, often without feedback. However, if they knew who needed their analysis, the goals of the end user, and how well their products addressed the needs of those customers, the analysts will know how to better tailor their products. Our interpretation of the LS attributes suggests that a feedback tool would be useful for the customer to communicate with the analysts. Such a tool would need to show the analysts who the customer is, what questions they needed answers to, and ultimately the value of their end products.

The operational implications of the other LS attributes also merit further exploration to determine the best way to implement them in the field. An example would be studying the need for analysts to have Trusted Sensing abilities tied in with Persistent Coverage. Trusted Sensing allows the analysts to work with the information they have without needing to check the elements of the sensors. That is part of the net-centric approach that gets analysts the information they need when they need it. The Information Triage attribute also requires more study. One way to implement this attribute might be to develop both "smart" sensors and backend systems that have an understanding of what is taking place in the battlespace.[11] The sensors can autonomously collect, allowing analysts to work on other tasks and alerting them only when necessary. The analysts are alerted based on priority schemas for their given missions.

The *Robust*, *Agile*, and *Adaptable* attribute is already being used on networks and other resources. Equipment, to include network "sniffers" and other protective tools, is a necessary resource to have but getting equipment accredited for operational use at the appropriate administrative levels is challenging. This LS attribute interacts synergistically with the *Affordable Open System Architecture* attribute. This pairing of attributes should be simple; an Affordable Open System Architecture is likely to be robust, agile, and adaptable. Nonetheless, problems that may arise are more people-driven than technology- driven (i.e. network security policies sometimes prevent or delay the addition of needed technologies to the system).

The LS attribute, *Anticipatory Observations* and *Interactive Engagements* can be interpreted in multiple ways. Decision-aids and event modeling software may not be readily available at this time, but when available, such tools will naturally assist with *Anticipatory Observations*. As mentioned, using Mica Endsley's SA model of *perception, comprehension, and projection*[12] improving SA for dynamic Intelligence, Surveillance, Reconnaissance (ISR) management begins with the perception of the current state of ISR assets, continues to comprehension of how current collection requirements are being met, and supports the projection of what the future collection needs will be and how they will be attained.

Bringing all of these attributes together for analysts and decision makers will drive the process of developing tailored situational awareness. Net-centricity permits quick implementation of some of the attributes. Still others need further development before implementation but the concepts and ideas are in place.

3.2 Discussion

This section addresses the IW Concept and the need for a DRT for ISR re-tasking.

3.2.1 Intelligence Wingman Concept

The IW Concept expedites information directly to the warfighter without having to go through the current stovepipe channels. This concept allows the warfighter to receive intelligence information directly related to his current situation in a timely manner. The current means of passing information through an LNO simply takes too long and has a high potential for errors. The LNO works between the CAOC and the DGS, passing information back and forth. The CAOC generally passes the information to the decision makers and warfighters after it has been passed from the LNO, who received the specifics from the DGS. The IW will be able to receive requests and pass products directly to and from the customer, thus saving time, reducing errors, and providing real-time feedback. The IW provides needed connectivity between the DGS analysts and the end customers needing the analysis.

In accordance with the LS concept, the IW is responsible for gathering information, analyzing it, and communicating it to the customer. This ensures the effective flow of information between the AF-DCGS and the warfighter. The IW gathers analytical products from the other analysts in the DGS and adds further analysis to the products. The IW passes the products to the customers needing the information. The IW will be the liaison between the customer (i.e. troops on the ground) and the DGS component (where first phase analysis is conducted). This person will be an integral member of the DART and will have an excellent knowledge of the different intelligence specialties, capabilities, and relationships with the overall objectives of the mission. As a member of the DART, the IW knows what is being reported on and when, as well as who is reporting on it and to whom. The comprehensive knowledge of the analysts and their responsibilities enables the IW to expedite the processing of products to the warfighter, eliminating the third and fourth parties involved.

The IW will gather and analyze data that is readily available within the DGS while anticipating contact from the customer. In order to gather information, the IW will need to stay abreast of the current missions throughout the DGSs. This includes intelligence missions outside of the IW's DART. When a call comes to the IW, it will give the answer immediately, obtain information quickly, or direct the customer to the correct place. The IW may talk to the mission supervisor within the DART, other intelligence cells, Mission Planners (MP), or the Mission Operations Commander (MOC) in order to fulfill the tasking by the customer. Communication may occur via secure chat, e-mail, or direct conversation. The information that is relayed to the customer may consist of verbal direction, written reports, and images sent directly to the warfighter. The IW should be allowed to distribute information by any means necessary (within policy) to expedite the information to the customer.

3.2.2 Need for Dynamic Re-tasking Tool

The DRT will aid in the execution and re-tasking phases of ISR. The current method, using the Sync Matrix (Figure 1) and platform collection lists, does not allow users to know what has been collected and what is left to be collected. The MPs at a DGS are able to determine what's collected and the availability of their specific platform but do not have knowledge of other platforms. The CM is currently forced to coordinate with many personnel to make a quick assessment. Bringing in the DRT gives everyone an updated assessment of the missions taking place. The DRT can be used and broadcasted to several users across the board.

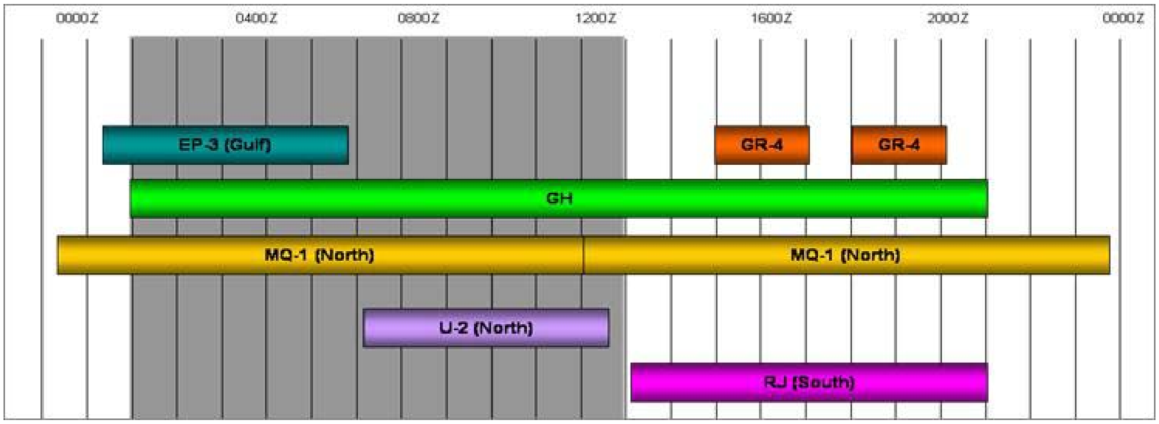

Figure 1. Example Sync Matrix

The DRT will show all of the candidate resources capable of meeting a new task, identify the most promising resource to examine for a new task, progressively refine the list of options that are and are not feasible for tasking, permit access to relevant details associated with each candidate ISR asset, evaluate mission characteristics and other factors affecting ISR asset availability, and receive a sense of the prospective ramifications associated with a decision to exploit one or another candidate ISR asset (Figure 2).

Figure 2. Notional Geospatial View - DRT

The DRT is an interactive tool. The users of the tool can perform “what if” changes to assess the optimization of changing the assets (Figure 3). The DRT also shows the locations of the platforms, as well as the collection status of the sensors. The number of targets assigned, versus targets collected, is also displayed. The completion of the overall mission is available along with the amount of time a will be available.

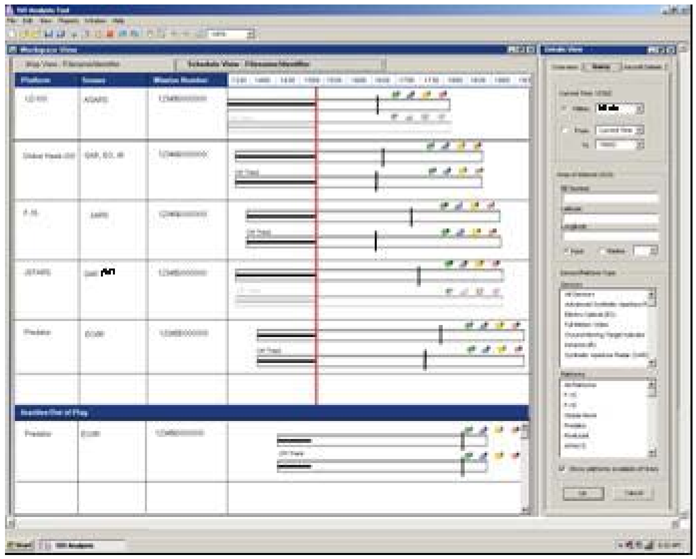

Figure 3. Notional Temporal View - DRT

3.2.2.1 Relationship between IW and DRT

The IW uses the DRT primarily as a means of mission awareness. The DRT provides search functions for anticipation of the availability of imagery and other products. The IW passes necessary information to any member needing an assessment. Tasks received from warfighters will be assessed against priorities in the DRT. This stacking of the priorities process will allow rapid feedback to be passed to customers. The IW will also pass information back and forth to the CM and the MPs, aiding the decision process for re-tasks.

3.2.2.2 Envisioned DRT Use by DGS Supervisors and Managers

Imagery Mission Supervisors (IMS) and MPs help plan, monitor, and dynamically re-task the collection mission while maintaining contact among the AOC, the sensor platform and the DGS analysts. This means they must be able to visualize planned, actual, and current sensor tracks and collection plans and communicate about the plan.

A collection-plan-centric view of the DRT supports these roles by providing access to the Reconnaissance, Intelligence, Surveillance, and Target Acquisition (RISTA) annex of the ATO via geospatial and temporal visualizations of planned and actual orbits, planned and actual collection footprints and real time information about the sensors operating in the theater.[11]

3.3 Illustrative Scenario

The intent of this scenario is to serve as a plausible operational context for presenting hypothetical layered sensing capabilities in AF-DCGS and AOC systems by the year 2015. It is not a prediction of future global events.

This scenario describes the operation of DGS with DRT and LS capabilities in support of a peace keeping and unconventional warfare mission. The scenario was developed to show the need to re-task the ISR assets and how the LS concepts can be tied into the DRT. The DRT is used to allow the CM to have an updated display of the ISR assets. The DRT is also used by the IW, who passes information and products to the customers in need.

3.3.1 Assumptions

The driving assumptions for this scenario are outlined below:

- Command, customers, and external intelligence community have accepted the DGS IW concept.
    - IW handles requests from high priority customers before handling requests from outside customers and only when it will not interfere with other duties in the DART.
    - IW handles requests from unsupported customers based on a first-come, first-served basis and latest time information is useful.
    - If the IW cannot fulfill a request in time to meet customer expectations the request may be dropped from the IW's task queue. Feedback must be provided to the customer explaining why the request was dropped.
- The ISR DRT concept is implemented
    - DRT is continuously updated with the most current ISR track and collection plans.
    - DRT track/plan visualization provides analysis functions that support gain/lose trade-offs for track and sensor changes.
    - DRT associates tasks with RFIs and EEIs.
    - RFIs and EEIs are tied directly to the reports and exploited imagery that support them.
- There is an increased emphasis on interoperability and cooperation between UAV systems.

3.3.2 Historical Background

The scenario used is an abbreviated version for this paper. All information in the scenario is used solely for conceptual purposes only.

The Republic is a fictional country that has been in economic and religious turmoil. They have been observed by the Allied Forces, with certain restrictions placed upon them for inhumane actions against their own people. Because of recent aggressive actions, the Allied Forces have decided to take action.

3.3.3 Scenario Background

The Republic fires an SSM at a US-flagged merchant vessel. There is no damage to the vessel, but it is captured by the Republic's Navy and is docked forcibly in the Republic's Port. The crew aboard the vessel is taken to a prison north of where the vessel is to be held. The Republic has notified the US of the actions and the US demands the return of the crew and vessel immediately. The Republic claims the vessel was in their waters and they have the right to capture the crew and vessel. The negotiations and talks fail.

The US starts preparing to build a presence near the region of the Republic's country. The CAOC directs a DGS unit to start their Intelligence Preparation of the Battlespace (IPB) of the area with given resources. US flyovers and surveillance sorties begin. With this surveillance, the US is monitoring the coastline and the vessel, with attempts at locating the crew. The sorties are utilizing traditional and non-traditional ISR assets.

Imagery and other sources of intelligence are being planned by the CAOC CM. The CM works with the DGS LNO to pass tasking to the DGS and receive intelligence reports. The LNO is responsible to answer questions that the CM has regarding the operations at the DGS. The MOC relays and receives any information to and from the LNO. The MOC passes the information to the appropriate supervisors within the DGS.

The DGS is responsible for exploiting the data that is collected by its assets' sensors. DGS has direct control of their own sensors and may have some degree of control of the flight paths of the platforms. The collection list is provided to the MP who is located within the DGS. The MPs monitor the status of the collected imagery, including the quality of the imagery. The MP can re-task the sensor, as long as it does not affect the collection plan. Re-tasks that impact the planned collection deck need to be approved by the CM at the CAOC. The MP notifies the MOC, who then contacts the LNO, who then contacts the CM and provides any necessary data. Decisions are made with limited resources and passed back down the chain to the MP. The limited resources include the ISR Synch Matrix, which has a static display of where the platforms are in their missions.

Interests in the mission change and the CM needs to re-task sensors. The CM looks at the Sync Matrix and planned collection decks to determine what asset(s) to task (Figure 4). The Sync Matrix and collection deck lists are usually not be up-to-date and do not provide any of the collection information with regard to the sensor. The CM, through the communication channels, inquires about certain platforms that can be re-tasked. The MPs receive the request, assess the collection needs, and pass a proposed plan to the CM.

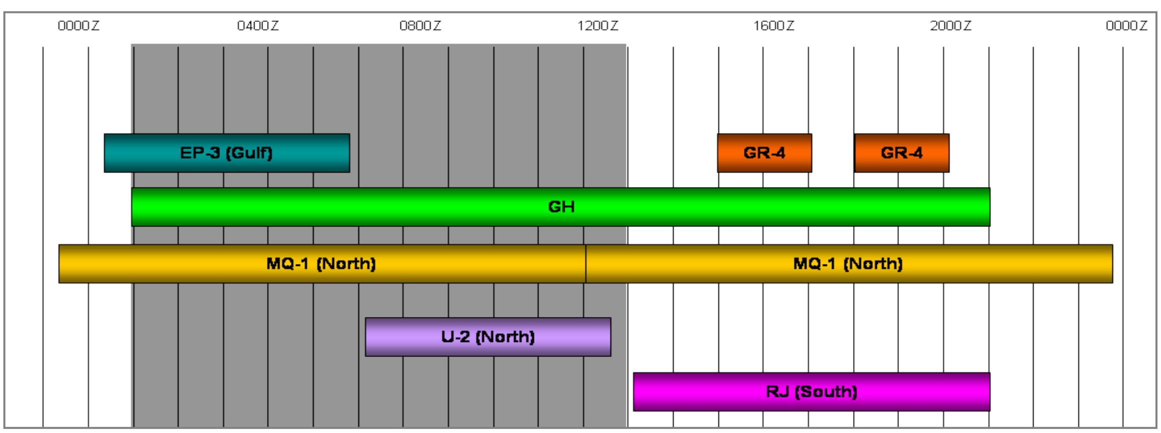

Figure 4. Static View of Sync Matrix

The CM weighs the options, against other received assessments, and tasks the DGS to reroute their collection plans due to changing priorities. The CM identifies the other platform and sensor that need to be rerouted to collect against other changing priorities. The CM notifies the Predator LNO who notifies the pilot and sensor operator of the changed plans. The Predator crew maps out the new route and notifies the exploitation unit of the decision.

The new plans are enacted and the CM receives updates from the LNOs, passed on from the units. The updates are not real time from the LNO since they have been relayed. When the CM receives information from the LNO, he passes it to customers in need. If the customers need more information, the requests are processed and the same steps are taken to task the assets. These types of events are what take place regularly, throughout a campaign.

4.0 RESULTS AND DISCUSSION

This section shows where the scenario could be better with the DRT, IW, and the LS concepts embedded.

4.1 DRT, IW, and LS Concept in Scenario

Several events happen during the course of the scenario that illustrate where the DRT and the LS attributes combined will help the process flow. The tools provided by these two concepts, along with the change in communication flow, will enable the decision-makers to receive better and faster analysis results. The use of changing events and priorities in a scenario can show the value added to this and other events.

This type of task is extremely inefficient and, unfortunately, recurs within the mission. Time is lost due to the number of communications required and the general lack of decision quality information. Due to the lack of updated sensing information meeting the CM's needs takes too long. Tasks are dynamically popping up that are changing the needs and the priorities.

The DRT would provide decision support that would enable the CM to determine the correct assets to use in a more efficient manner. The communication channels are too long in the current scenario. The DRT would have given the CM instant access to visualize the best case scenario for re-tasking without having to communicate with so many others. The DRT would have presented the ISR assets and how they could have been used differently. The DRT would have enabled the CM to know where the assets were in the collections and helpful to visualize the best and most efficient re-tasking.

With the best situations presented, the CM is able to communicate with the LNO to direct the necessary changes (Figure 5). The best case scenarios are at the finger tips of the CM through the DRT, eliminating lost time within the communication flow. The usability of the DRT makes the decision support easy for the CM. Allowing communication to the MPs through the DRT would be beneficial.

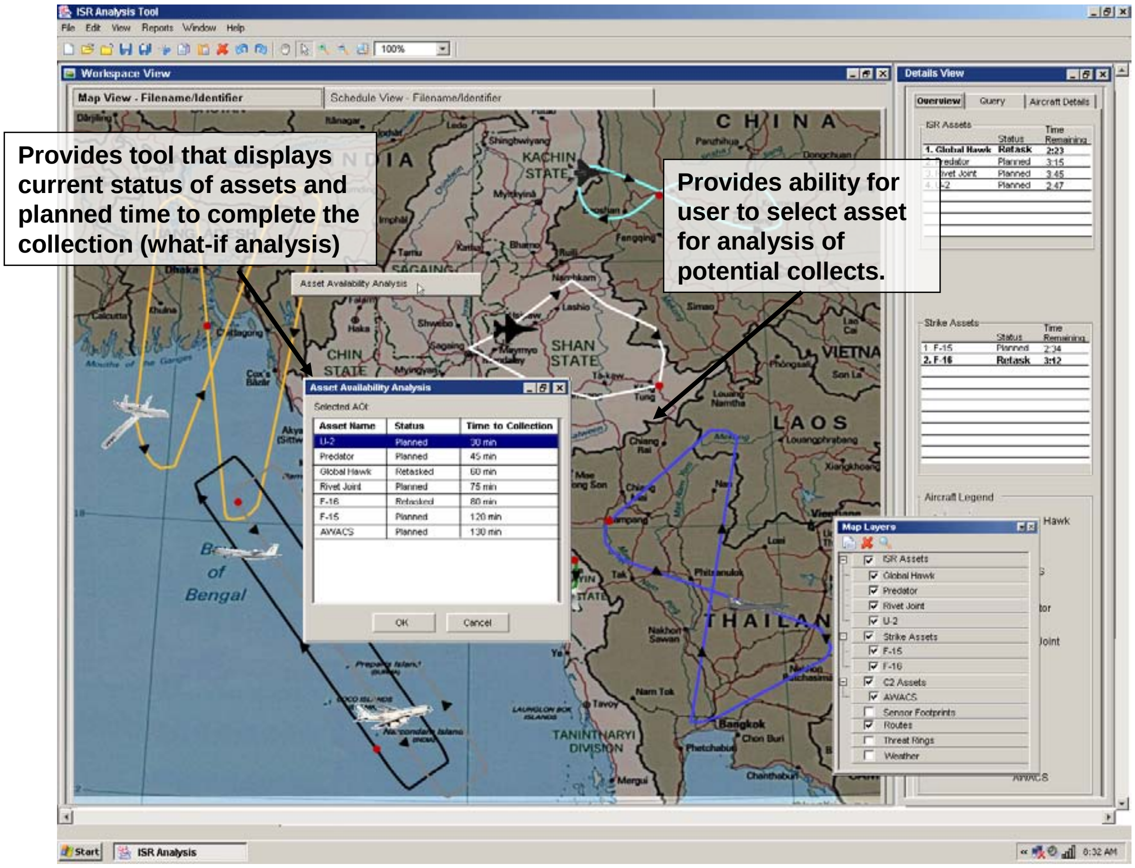

Figure 5. Interactive DRT for Real-time Asset Status

The IW could also work with the DRT in the scenario. The proposed IW concept enables the analysts to answer the direct questions of the customers. The IW has access to the DRT, so the customers could be given the status of reports (i.e. when to expect their reports). The IW passes products directly to customers, eliminating the time it takes for LNOs and other parts of the CAOC to pass on the information. The IW provides the ability to understand EEIs and know what the customers are requesting. When the taskings are unclear, the IW contacts the customers directly to identify the exact needs.

There are parts of the communication flow that are still missing, but bringing in more of the LS concept in the future will ease the processes. Communication tools for the IW and the customers may still be lacking, but they should be brought along as the concept is matured. The DRT has capabilities that the IW can use, but the communication areas need to be researched to flush out the details.

5.0 CONCLUSIONS

This section includes coverage of conceptual plans and LS attribution tie-ins.

5.1 Conceptual Plans

There are ways to take the LS attributes and transcribe them into current scenarios, aiding the way analysts perform their tasks. Analysts have the customers' interests in mind but don't have a way into the customers' mind. The concepts discussed, including the IW, could be introduced with little further study. The IW could reduce the number of steps between analyst and customers since the IW knows who is asking the question and for what purpose and provide better answers to the customers. The DRT and other communication tools will need to be implemented to bring the concepts together.

5.2 LS Attribution Tie-Ins

The DRT concept works in conjunction with the IW concept to support most of the attributes of LS for production and dissemination of situational awareness. The LS attributes tied within the DRT, IW, and Sensors and Technology work together to achieve Tailored Performance (Figure 6).

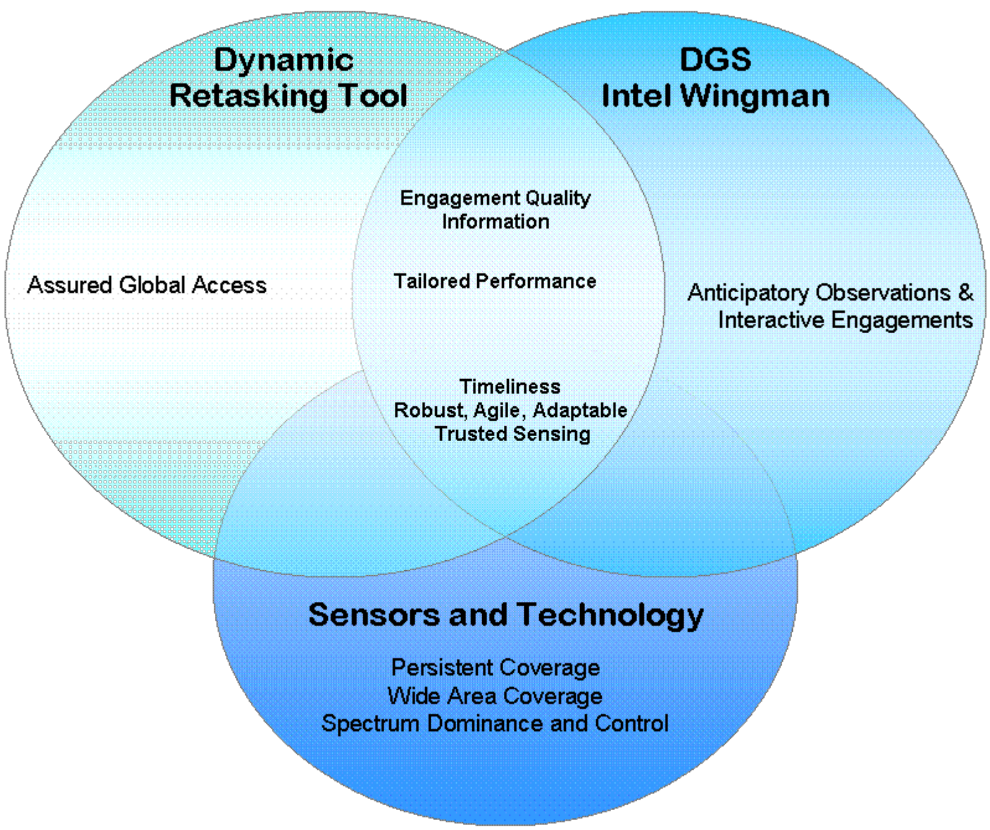

Figure 6. Achieving Tailored Performance

- Assured Global Access
  Global Access means not only that the sensor can reach the AOI but also that the end customer can find, acquire, and use all the information available from that sensor.

- Engagement-Quality Information
  Information is of engagement-quality when it can support decision making in military situations. The DRT will aid in ensuring the right targets are being collected at the optimal time. It also provides information regarding the gain and loss of targets when they are replanned.

- Timeliness
  The DRT provides many time savers by eliminating the need for many channels of communication. With one common tool available to everyone, decisions will be made more quickly.

- Trusted Sensing
  The DRT provides the best scenarios for choosing the optimal sensor for collection. The IW combination creates trust between the customer and the DGS by facilitating direct question and answer communication.

- Persistent Coverage
  The analysts and IW work together using the DRT to answer questions presented by the customers.

- Wide Area Coverage
  In addition to Persistent Coverage, having more sensors over the area provides more imagery, both still and video, to exploit. ATR technology increases the ability to handle the additional area coverage.

- Robust, Agile, and Adaptable
  The robustness of the DRT, between the IW and the other users, is a large success on its own.

- Spectrum Dominance and Control
  The ability to fly the sensors in the needed area is an example of this attribute. The analysts find targets that could be dangerous and inform the necessary personnel. Decisions are made with the DRT, enabling assets to remain in the air and focus on what is needed.

- Anticipatory Observations and Interactive Engagements
  The IW predicts actions through analysis of data for decision makers. Presenting scenarios for sensor utilization enables better engagements for customers.

- Tailored Performance
  The IW acquires the correct imagery, when needed, providing proper reports to customers.

6.0 RECOMMENDATIONS

A study of information workflow is necessary to improve the processes in place. Without studying new techniques, information will continue to be stove-piped and take longer than necessary to get to the end user. As seen in Figure 6, the concepts are all tied together when the DRT and IW work with the sensors and technology available. Constant communication between the analysts and the end users should ease the fit of the LS concept, thereby enabling decision makers the "timely, actionable, trusted, and relevant information necessary for situational awareness"[2] that will allow them to achieve the desired military/humanitarian effect.

The DRT has been researched and conceptualized and needs to be presented to the field to show its worth. With additional research and funding for implementation, it's a tool that will have an immediate impact on the efficiency of the CM and other effected mission areas.

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[3]Joos, K.P., "Command and Control of Distributed Intelligence, Surveillance, and Reconnaissance Operation." April 2006, Air Command and Air Staff College, Air University, Maxwell AFB, Alabama.

[4]AF Distributed Common Ground System also known as the "Sentinel" weapon system, conducts imagery, cryptologic, and measurement and signatures intelligence activities. Regionally-focused, globally-linked, AF-DCGS is the cornerstone of successful AF, Joint and Coalition ISR operations. (http://www.afisr.af.mil/units/480thiw.asp)

[5] http://www.afisr.af.mil/library/factsheets/factsheet.asp?id=11982

[6] http://www.dtic.mil/futurejointwarfare/concepts/iw_joc1_0.pdf

[7]http://fcw.com/articles/2007/08/22/dod-intell-community-to-collaborate-on-network-access-control.aspx

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LIST OF ACRONYMS

ACF	Analysis Correlation and Fusion
AF-DCGS	Air Force Distributed Common Ground Station
AFRL	Air Force Research Lab
AFRL/RY	Air Force Research Lab, Sensors Directorate
AFRL/RHCS	Air Force Research Lab, Human Effectiveness Directorate's Cognitive Systems Branch
AOC	Air Operations Center
ATO	Air Tasking Order
ATR	Assisted/Automated Target Recognition
CAOC	Combined Air Operation Center
CM	Collection Manager
DART	DCGS Analysis and Reporting Team
DGS	Distributed Ground System
DGRT	Dynamic Re-tasking Tool
EEI	Essential Elements of Information
IMS	Imagery Mission Supervisor
IPB	Intelligence Preparation of the Battlespace
ISR	Intelligence, Surveillance and Reconnaissance
ISRD	Intelligence, Surveillance and Reconnaissance Division
LS	Layered Sensing
LNO	Liaison Officer
MOC	Mission Operations Commander
MP	Mission Planner
RISTA	Reconnaissance, Intelligence, Surveillance, and Target Acquisition
RFI	Request for Information
SME	Subject Matter Expert
TTP	Tactics Techniques and Procedures