

Developing a Situation Awareness Environment for the Distribution Process Owner

Recommendations for US Transportation Command

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This study addresses three basic questions: (1) what should be the endgame objective for distribution process owner (DPO) situation awareness (SA)? (2) what is in the critical path to achieve the objective? and (3) how does the DPO get to the objective end state? DPO decision makers need to have confidence in their information for successful SA. Integral to this trust is the requirement for accurate, timely, and relevant information; this leads to confident and actionable decision making.¹ Decisions based on confidence in trusted information lead, in turn, to effective and efficient logistics actions in support of global Department of Defense (DOD) operations. Therefore, US Transportation Command (USTRANSCOM) should pursue information confidence as the endgame objective for DPO SA. That assertion leads to the thesis that the DPO should articulate the need for information confidence as its fundamental requirement for an effective and successful SA environment. Considering information confidence as its primary objective will drive the DPO to understand all of the necessary critical-path elements to achieve success.

In addressing how the DPO reaches its objective, this study provides three macrolevel recommendations for USTRANSCOM:

1. leverage pertinent SA industry research and adopt user-centered design as the foundation for a DPO SA environment;
2. adopt a knowledge-centric approach to DPO culture by defining ownership of information, processes, and business rules; and
3. address critical-path concerns for DPO SA through appropriate governance forums.

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These broad findings highlight the need for the DPO to advocate development of information-confidence factors as a microlevel recommendation for its SA environment.

A basic definition of *information-confidence factors* is a visual, audible, or textual indicator that communicates a level of confidence (low, medium, or high, based on appropriate business rules) for a given element of SA information. The basic business rules associated with information-confidence factors should be based on providing timely, accurate, and relevant information to the decision maker (see fig. 1).²

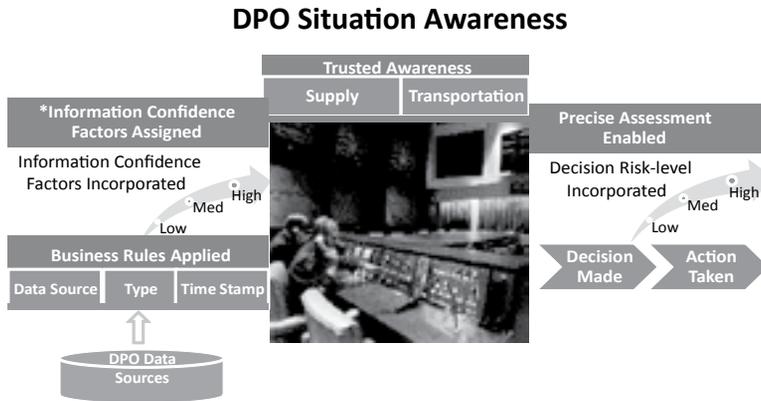


Figure 1. Incorporating information-confidence factors for SA

As a foundation to understanding the concept of information confidence, other elements should be addressed. This study introduces some of these, for instance, the basic process of decision making within the DPO SA environment. Its major premise, however, is that information confidence lies within the critical path of successfully providing actionable (decision-ready) information and, therefore, should be an integral part of any best-practice-driven solution (see fig. 2).

This research provides recommendations for USTRANSCOM leaders to consider as they embark upon a major business transformation effort called “Agile Transportation for the 21st Century” (AT21) and rolls out information technology (IT)-enabled capabilities as part of its corporate services vision.³ The DPO SA environment will be integral to successful realization of the AT21 vision. USTRANSCOM commander, Gen Duncan J. McNabb, noted in a 27 March 2009 statement before the Senate Armed Services Committee that “when fully operational, AT21 will provide the warfighter full distribution pipeline visibility and enable throughput management at critical



Figure 2. DPO SA decision-making model (*information confidence is the first step)

ports and waypoints around the world.”⁴ Undoubtedly, the success of AT21 will depend upon confidence in the underlying information.

Background

This study leverages specific research centered upon designing for SA and human factors engineering as the basis for its recommendations for USTRANSCOM. As a further clarification, one should consider that the distribution process is part of the greater domain of logistics within the DOD. As such, logistics-centered topics are directly relevant to the DPO discussions herein. A basic definition of SA is required to establish the baseline discussion. There are at least 26 SA definitions, according to a 2001 systematic classification of SA definitions by Richard Breton and Robert Rousseau.⁵ The well-known Endsley definition is used herein: “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.”⁶

This translates well for the DPO environment and the capabilities envisioned for AT21. Consider Endsley’s definition of SA as it relates to the capability of AT21 to provide distribution pipeline visibility and

enable throughput management. “The perception of the elements in the environment” relates well to visibility of assets within the distribution pipeline such as material supplies, transportation conveyances (a ship, plane, truck, or railcar), supply depots, and ports of embarkation and debarkation. “Within a volume of time and space” translates nicely to the location of a transportation conveyance and timeliness of the relevant information to enable throughput management of people, equipment, and supplies. And finally, “the comprehension of their meaning and the projection of their status in the near future” enable visibility and planning for throughput management by reporting whether the item of interest is expected to arrive early, on time, late, or not at all.

The Importance of Information Confidence

One key to successful logistics planning and execution is the need for actionable information. For information to be actionable, however, the decision maker must be confident in the information being presented. Confidence is fundamentally achieved when the decision maker accepts that the information being acted upon meets the requirements of timeliness, accuracy, and relevance. To deliver these requirements for decision makers, it is necessary to develop and present information-confidence factors (high, medium, or low) in the SA environment. The decision maker can then consider a level of risk (low, medium, or high) associated with the decision to be made and decide—based on the confidence and risk levels—whether or not to make a decision that will lead to a subsequent action. The importance of information confidence in the decision-making process leads one to deduce that information-confidence factors are in the critical path for the logistics decision maker. Therefore, information-confidence factors should be addressed as part of the solution to providing situation awareness for USTRANSCOM (see fig. 3).

To better understand the importance of information confidence, consider the example of a key logistics decision affecting the safety and lives of war fighters during Operation Iraqi Freedom.⁷ In 2004 enemy threats evolved as insurgents strategically placed improvised explosive devices (IED) along roads traveled by US forces. The interim solution to help counter that threat was to ship add-on armor for installation on US vehicles in Iraq. The planners in the joint operations center at USTRANSCOM were working diligently with their counterparts at the USAF’s Air Mobility Command (AMC) and the Army’s Military Surface Deployment and Distribution Command (SDDC) to ensure the most expeditious shipping solution (air and/or surface).

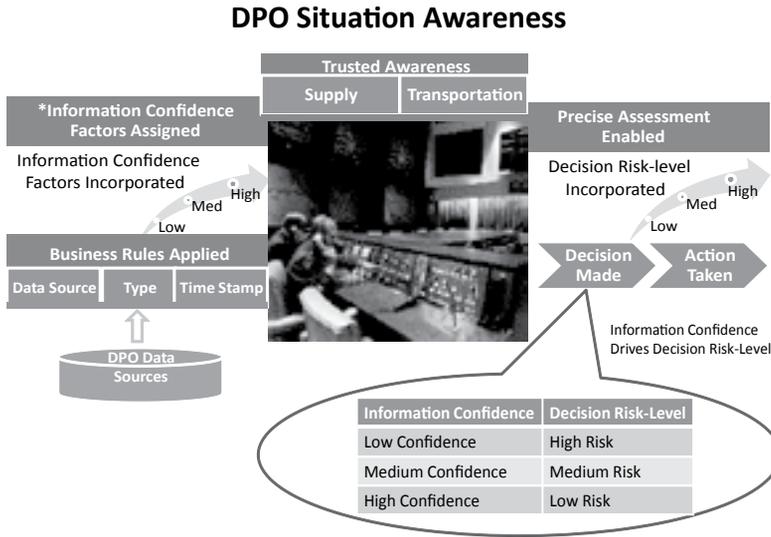


Figure 3. Relationship of information confidence to decision risk level

Although planners were leveraging all of their IT systems capabilities, there was no automated way to indicate a level of confidence in the information associated with timeliness, accuracy, or relevance. Conflicting information was available, and much of it was being validated verbally by a “human in the loop” prior to final decisions for shipment to Iraq by air or surface. Traditionally, critical logistics decisions have been made only after checking and double-checking information gained from the various IT systems available across the department, followed by verbal confirmation on the agreed-upon information from all parties involved.

By implementing information-confidence factors associated with corresponding risk levels, decision makers can focus attention on the most critical decisions, trusting business-rule-based software to provide confidence and risk levels versus having to manually engage in the process every time. The bottom-line benefit to users is that they can allow software to perform confidence checks (starting with the least-critical decisions). That, in turn, frees decision makers to perform more critical analysis for the higher-risk decisions. Therefore, it is necessary for USTRANSCOM to define, develop, and field the capability to display information-confidence factors leading to trusted situation awareness and effective logistics decision making.

The Critical Path to DPO Situation Awareness

How does the DPO reach the objective end state of information confidence? To answer that question, this study highlights other critical-path requirements to illustrate how information confidence drives effective logistics decision making. The critical path to deliver actionable or decision-ready information contains DOD-level concerns, as well as those within USTRANSCOM's direct sphere of influence as the DPO and distribution portfolio manager for DOD distribution.

USTRANSCOM should continue to address concerns with the Office of the Secretary of Defense (OSD), the Joint Staff, the military services, and agencies such as the Defense Logistics Agency (DLA), Defense Information Systems Agency, and others as appropriate to realize the stated SA environment end game. Of the many elements external to the DPO, three stand out as essential for success within the military services' purview to organize, train, and equip its forces: (1) the need for trained personnel engaged in well-defined and understood DOD logistics business processes, (2) a disciplined approach to information gathering and reporting, and (3) universal access to information through appropriate fielding of IT.⁸

Logistics personnel are key to successful delivery of trusted SA for decision makers. Therefore, the proper mechanics for conducting the business of logistics should be inherent in training, and the impact of shortcutting processes that support logistics visibility should be understood. For example, failure to ensure that cargo is appropriately marked with accurate shipping labels or radio-frequency identification (RFID) tags causes information gathering and reporting problems within the supply and transportation domains ranging from rework at the next location to reordering a critical supply item that might be needed for a mission-essential task or operation. Trained personnel must have the discipline to ensure timely gathering and reporting of information to enable information confidence for decision makers and to guard against "the possible loss of life and equipment resulting from poor planning" based on incomplete or inaccurate logistics information.⁹ Along with training and disciplined execution of logistics processes comes the requirement to ensure complete access to the necessary IT solution that supports execution of logistics duties. Today, access to logistics information via Web-enabled services and applications is prolific through the fielding of capabilities like the Global Combat Support System-Joint Common Operating Picture Deployment and Distribution (GCSS-J COP D2) structure. All new IT services should be Web-enabled to ensure the widest access possible.

The scope of this research does not allow in-depth discussion regarding the importance of these DOD-level critical-path items or others like them. However, the DPO should pursue their accomplishment to realize its objective of a successful SA environment. It should also continue to leverage governance forums like the Distribution Executive Board and the Distribution Transformation Task Force to address essential elements within the critical path of providing decision-ready information for decision makers.¹⁰

USTRANSCOM-Centric Critical-Path Discussion

Three DPO-centric elements are necessary for USTRANSCOM to achieve success: senior leader buy-in and staff advocacy; ownership of processes, information, and business rules; and adopting a knowledge-centric culture.

Senior Leader Buy-in and Staff Advocacy

Delivering a secure SA environment for the DPO requires that senior leaders are an integral part of achieving the endgame objective. This is apparent from General McNabb's statement to the Senate Armed Services Committee. In addition to senior leader buy-in, the power of the entire staff should be focused on the same goals. Success is predicated on a horizontal, integrated team approach to planning and executing the solution. Isolated requirements development and materiel solution design and fielding should be viewed as counter-productive to a successful outcome.

Ownership of Processes, Information, and Business Rules

To achieve the desired confidence in information necessary for logistics decision makers in a future DPO SA environment, one must first ensure that ownership of major business processes and the information supporting those processes is clearly defined and that those identified as responsible are empowered, resourced, and engaged accordingly. For example, who owns the strategic surface transportation process from the seaport of embarkation to the other end at the seaport of debarkation? One can argue that ownership is split between two of USTRANSCOM's component commands, the Army's Surface Deployment and Distribution Command (SDDC) and the Navy's Military Sealift Command (MSC), depending on the type of sealift employed (contract or organic). This is one example of the complexities associated with the duties of distribution process owner. Clearly understanding who owns a business process is critical to

determining other key relationships fundamental to the discussion of information confidence.

The process owner should also own the information related to that process and be solely responsible for updating and reporting that information within the decision-making environment. In the current DPO environment, a user can determine which information source (IT system) to access for logistics information. This can, and does, result in different answers to the same question. To eliminate this occurrence, an integral first step in the right direction is to assign responsibility or ownership of information to an organization. Next comes designating an authoritative information source and providing a time stamp associated with currency of the information. This should enable tagging of information and subsequent development of information-confidence factors.

Achieving a successful DPO SA environment also involves business rules. The information owner should make information that is critical to a future DPO SA environment available in a standard manner that articulates the confidence level for the information being presented. The same pertains for other major process owners in the distribution domain. AMC should be responsible for airlift transportation information, the DLA and military service supply organizations should manage supply information, and USTRANSCOM should oversee information for joint intermodal transportation decisions. The information should be “tagged” to indicate high, medium, or low confidence based on a definitive, minimal criteria articulated as business rules.

To understand this concept, consider the following notional example of an information tag for an airlift transportation manifest:

1. type of information (e.g., airlift manifest),
2. organization responsible and point of contact for the information (e.g., Tanker Airlift Control Center: TACC OpsCtr@AMC.af.mil, 618-229-3131),
3. authoritative information source (e.g., “Gates”), and
4. date/time stamp of last update for the information provided.

By providing basic tag information (also known as metadata) one can next move on to developing the business rules for displaying information-confidence factors (see fig. 4).

Adopting a Knowledge-Centric Approach to DPO Culture

A trusted SA environment for DPO decision makers requires a culture that values knowledge as a central theme for success. Along the path to

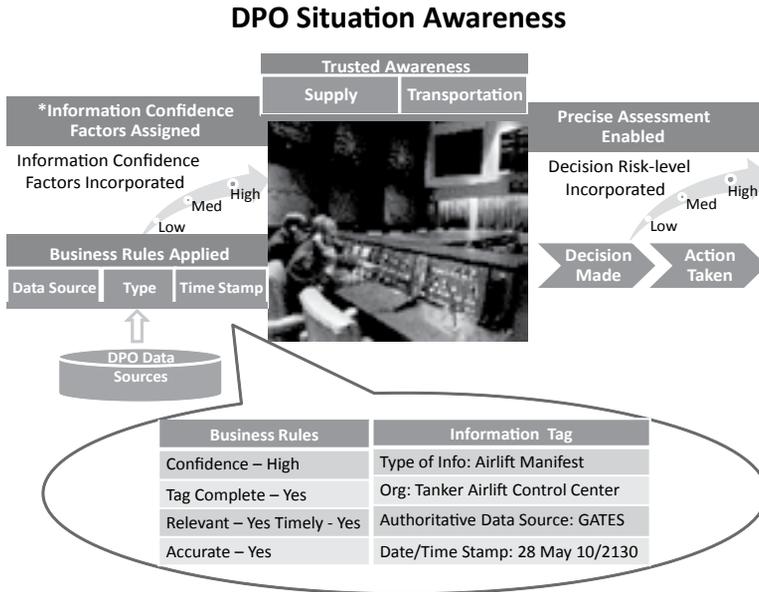


Figure 4. Example: business rules and information tag

becoming a knowledge-centric organization are the fundamentals of disciplined information management. These fundamentals include, but are not limited to, some of the following basic information management principles. A knowledge-centric organization should tag and categorize information in a standard way, with agreed-upon naming conventions, to be able to discover the information with an automated search engine. Otherwise, even the most powerful search engines available will only retrieve unorganized lists of disjointed information.

Practicing the fundamentals of disciplined information management is foundational to achieving information confidence and realizing ultimate transformation to a knowledge-centric organization and culture. None of these can be achieved through technology alone, and all should be realized to ensure information confidence. The DPO should continue to institutionalize ownership of processes, information, and business rules to fully reap the benefits of a DPO SA environment enabled by technology.

Analysis of Situation Awareness Research

To understand why information confidence is in the critical path of DPO decision makers, consider the mechanics of the decision-making

process within the SA environment (see fig. 1). The decision maker is the center of focus in the SA environment. The desired outcome of the model is a trusted decision which then leads to an appropriate action being taken in response to the information being presented. To achieve a trusted decision, the decision maker must have confidence in the information. The purpose of providing information-confidence factors is to enable the decision maker to proceed based on a visible level of confidence (high, medium, or low), such that minimal rework is required to validate and/or verify information prior to an ultimate decision being made.

A review of readily available SA research led to several primary references that were pertinent to USTRANSCOM's request for best practices for a COP for D2, that is, the DPO SA environment. Two were considered most pertinent for discussion: *Designing for Situation Awareness, An Approach to User-Centered Design* by Mica R. Endsley, Betty Bolte, and Debra G. Jones; and *A Cognitive Approach to Situation Awareness Theory and Application*, edited by Simon Banbury and Sebastién Tremblay.

Endsley has worked extensively in the SA field and is president of SA Technologies in Marietta, Georgia. Her area of SA expertise is in aviation, the military, and the medical profession. Her work provides a detailed approach to SA that focuses on the business of the user and a holistic SA business solution that guides development through user-centered design, focusing on user requirements, and applying SA-oriented design to the entire system of the mission environment.¹¹

Banbury and Tremblay complement Endsley's work by providing a broader review of SA research. Their book includes 17 chapters from 41 contributors. Endsley provides her insights regarding progress and directions for SA, providing a brief 2004 update to her extensive research from 2003 (see chap. 17). Banbury and Tremblay look critically at defining and modeling SA, questioning Endsley's 2003 work as being focused on a basic descriptive approach instead of a detailed prescriptive approach. While there may be some validity to that criticism, Endsley's detailed template for design principles is an excellent source from which USTRANSCOM can draw to perform a comprehensive baseline review of user requirements as it moves to a future DPO SA environment. The Banbury and Tremblay work draws credibility and strength from the 41 individuals across theoretical perspectives, research approaches, and domains of application.¹²

Why User-Centered Design and SA-Oriented Design Principles?

Foremost, Endsley's work impresses as a comprehensive design checklist that identifies the user as the appropriate focus versus driving solutions based on technology. She compares user-centered design with technology-centered design and ends with a detailed list of 50 design principles that appear to cover a grounded approach for addressing requirements for SA design. A review of the design principles reveals six areas for consideration: general, certainty, complexity, alarm, automation, and multioperator.¹³ To reinforce the value of this list, consider the primary assertion of this study: USTRANSCOM should identify information confidence and information-confidence factors as key requirements for its future SA environment, as articulated and supported by the proposed DPO SA decision-making model (see fig. 2). Endsley's "certainty" design principles speak directly to information confidence as follows: (1) explicitly identify missing information, (2) support sensor reliability (e.g., passive and active RFID sensor reliability), (3) use data salience in support of certainty, (4) represent information timeliness, (5) support *assessment of confidence in composite data*, and (6) support uncertainty management activities. More specifically, Endsley notes, "as more systems employ classification algorithms, sensor fusion, and decision support systems, the need will arise to *appraise operators of the reliability or confidence levels* of these systems' outputs."¹⁴

One inclined to disagree with the need for information-confidence factors will possibly cite the net-centric data strategy that identifies an unrealized goal within the DOD—to introduce information pedigree as part of the overall data strategy for the department.¹⁵ Many of the standards or strategies for data in the DOD have been "all or none" propositions. These strategies have arguably led to shortfalls in expectations due to the enormous amount of work required to engineer information pedigree into the DOD data environment. The recommendation herein for implementation of information-confidence factors focuses on only relevant data. In other words, USTRANSCOM should leverage the power of user-centered design to identify the relevant data or information necessary to provide the most pertinent SA for its decision makers. The application of information-confidence factors should start with the relevant information that is valued most by USTRANSCOM and move forward based on an appropriate business case that identifies the return on investment. This will preclude much of the discussion regarding magnitude of effort and feasibility.

It will also cause the DPO to consider what information is most critical to its core mission and provide appropriate focus for SA designers.

If Not User-Centered Design, Then What Should Be the Focus?

Some may still argue for a technology-centered versus user-centered design. However, the focus should be on human factors such as processes, information assimilation, business rules, and measuring successful mission outcomes. Reaching the DPO objective is also about technology—the good news is that technology is well matured and deployed in today’s Web-enabled, connected IT world. Access to information is provided universally via portal technology, geographic visualization is readily provided by mapping tools like Google Earth, data warehouses and operational data stores are foundational capabilities in any corporate IT environment, and reusable Web portlets provide active content for the user experience. The user experience or interface is realized through common capabilities like iGoogle where a user can customize the views that are most relevant, such as international news, weather, sports, and so forth. All of the foregoing is made possible due to the years of foundational code development and subsequent proliferation through reuse in the world of software development. While technology is in the critical path for successful fielding of SA tools, it is well matured and readily available for implementation by any fundamentally competent IT organization. Therefore, a technology-centered design approach is not the answer for the DPO. Focusing on human engineering factors associated with user-centered design allows developers to focus on important outcomes, such as information confidence for the decision maker. Perhaps most critical to success, this strategy places users at the center of attention and involves them from concept to the fielding of capabilities.

Recommendations for USTRANSCOM

SA research and design appear to have come a long way in the last 10 years. SA research for the military has centered on the command and control domain. But the basic research, which is focused on design principles, crosses over to the logistics domain. (Several reference books have been cited in this study.) Based on this research and the author’s personal experience with USTRANSCOM operations and IT programs, USTRANSCOM is at an opportune juncture to benefit from the extensive work done by many in the SA profession.

Leverage SA Industry Research and Adopt User-Centered Design Principles

The most relevant research for USTRANSCOM at this point in its maturity with DPO SA is that by Endsley, Bolte, and Jones. Based on their work, this paper identifies information-confidence factors as a micro-level recommendation and one of the key elements in USTRANSCOM's critical path to achieving successful DPO SA. Their approach to SA-oriented design is founded on three overarching principles that are recommended as best practices for USTRANSCOM leaders to consider as they continue transformation of the AT21 initiative: (1) organize technology around the user's goals, tasks, and abilities; (2) implement technology according to the way users process information and make decisions; and (3) use technology to keep the user in control and aware of the state of the system.¹⁶ The author's research offers a list of 50 design principles that the DPO should use as the basis for development of its SA requirements and subsequent development of a DPO SA environment. The research also directly supports the need to address what is termed *certainty design principles*, leading the DPO to address information confidence and understand the value of displaying information-confidence factors as part of its SA solution.

Adopt a Knowledge-Centric Approach: Define Ownership of Processes, Information, and Business Rules

By adopting a knowledge-centric approach and redefining the DPO culture as dependent upon trusted information, the DPO will set the tone for taking its SA game to the next level. The DPO should not treat all information as equal in terms of relevance to its mission. As a start, the process owner should determine which information is relevant to its SA environment and then establish information-confidence factors. In turn, this will enable decision makers to more expeditiously make critical logistics decisions. To embrace a knowledge-centric approach, the DPO should institutionalize disciplined information management principles. Otherwise, future DPO SA solutions may be relegated to providing the latest ways to present "uncertain" information, or users will continue to be burdened with checking, double-checking, and calling someone to ensure information confidence prior to making a decision. To solidify this recommendation, the DPO should adopt process, information, and business-rule ownership, to include identification of ownership stewards and measurement of information and knowledge management performance.

Address Critical-Path Concerns for DPO SA in Appropriate Governance Forums

As outlined earlier, several factors influence the achievement of information confidence. They range from personnel training, disciplined information reporting, and access to appropriate technology, to ownership of processes, information, and business rules—to name but a few. USTRANSCOM should continue to leverage the DPO and department-level governance forums to better ensure information confidence within the DPO SA environment. Some elements are directly within USTRANSCOM's control (e.g., senior-leader buy-in), and many are influenced at the DOD level.

Conclusion

This study posed three questions to help frame the discussion. First, what should be the endgame objective for DPO SA? The answer proposed forms the basis for the argument that the DPO should articulate the need for information confidence as its fundamental requirement for an effective and successful SA environment.

Secondly, what is in the critical path to achieve the DPO SA objective? The study provided an overarching look at several elements within the critical path for success (some within USTRANSCOM's direct control and some requiring coordination at the DOD level of responsibility). Finally, it asked, how does the DPO get to the objective end state? The recommendations given should provide a sound start to USTRANSCOM's pursuit of a future DPO SA environment. The author's intent was to address the DPO's considerations in a holistic manner, spanning multiple areas that will undoubtedly influence USTRANSCOM's ability to transform to the DPO of the future.

There is no single silver bullet for success here. As USTRANSCOM moves forward with DPO transformation through implementation of the AT21 initiative and delivery of IT-enabled capabilities through its corporate services vision, it should take advantage of the aforementioned research, best practices, and industry standards. This will help guide its end game for a future DPO SA environment informed by an appropriate cost-benefit analysis to determine the value of such an undertaking.

Notes

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2. Ibid.
3. Scott D. Ross, "The DPO's Corporate Services Vision: Learning from E-Commerce Leaders," release no. 090218-1, 18 February 2009, <http://www.transcom.mil/pa/body.cfm?relnumber=090218-1>.
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12. Ibid., xiv.
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Abbreviations

AMC	Air Mobility Command
AT21	Agile Transportation for the 21st Century
COP	common operating picture
D2	deployment and distribution
DLA	Defense Logistics Agency
DOD	Department of Defense
DPO	distribution process owner
GCSS-J	Global Combat Support System-Joint
IED	improvised explosive device
IT	information technology
MSC	Military Sealift Command
OSD	Office of the Secretary of Defense
RFID	radio-frequency identification
SA	situation awareness
SDDC	Surface Deployment and Distribution Command
USTRANSCOM	US Transportation Command