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Sense and Respond Logistics

Integrating Prediction, Responsiveness, and Control Capabilities

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Summary

Sense and respond logistics (S&RL) or, more broadly, sense and respond combat support (S&RCS), has been the subject of much discussion. However, many of its operational components have not been fully envisioned and both current and projected technological apparatus is limited. Moreover, it is not clear how these components can be incorporated or function within a military logistics or combat system. This monograph identifies the elements of S&RCS and shows what is necessary to use the concept within the military, and more specifically the Air Force, combat support system. The monograph further surveys the state of technology necessary to implement S&RCS capabilities within the military and identifies both the technical work that needs to be further developed and the Air Force organization most appropriate to manage the development of these capabilities.

Military S&RCS Defined: Integration of Predictive, Responsiveness, and Command and Control Capabilities

S&RCS capabilities involve predicting what will be needed and responding quickly to anticipated or unanticipated needs to maintain military capabilities. In the past, theories about prediction and responsiveness were framed as *competitive* concepts. This monograph shows the need for both *predictive* tools and *responsive* systems working together within a combat support command and control (CSC2) framework to create military capabilities. Although some elements of S&RCS have been exercised throughout the Air Force's history, years were required to

develop and understand the relationship between predictive tools and responsive logistics management and processes and make it feasible to design a responsive and adaptive combat support (CS) system able to meet today's and tomorrow's defense challenges in a more effective and efficient manner. Recently, conceptual, political, budgetary, and technological developments have converged, necessitating and permitting the transformation from traditional logistics support policies and practices into a comprehensive agile combat support (ACS) system able to achieve the required balance among scarce resources and improved processes that can replace mass with speed (i.e., large numbers of assets in place versus rapid distribution of smaller increments of resources as they are needed or consumed). CSC2 is key to this transformation. The Air Force vision of the CSC2 architecture and current implementation actions of that architecture are important steps in overseeing and coordinating the complex set of support functions essential to reliable support of military operations.

It is important to distinguish the inclusive concept of combat support from the smaller subset of logistics. The traditional, but narrower, definition of logistics includes the disciplines of supply, maintenance, transportation, logistics plans, munitions, and sometimes contracting. The smaller subset is commonly referred to as logistics with a little "l". Combat support is sometimes referred to as logistics with a big "L", since it incorporates all aspects of establishing and supporting a base of military operations. Combat support incorporates all of the little "l" logistics areas but also civil engineering, force protection, billeting, messing, and other services required to support a fighting force in the field.

This monograph focuses on the larger view of logistics, which incorporates the broader concept of all CS requirements. Blending principles of S&RL with the broader and inclusive definition of combat support, we have created the acronym S&RCS, which we use throughout this study. S&RCS is an essential piece in combat support that facilitates ACS.

The CSC2 Architecture

One contribution of this monograph is to define the relationship between CSC2 and S&RCS. This monograph presents CSC2 as a key enabler of S&RCS and indicates why it is necessary to implement S&RCS in military applications. CSC2 involves the following:

- Joint development of a plan (campaign, peacetime training, or others) in which logistics process performance and resource levels are related to desired operational effects, e.g., projected weapon system availability, forward operating location initial operating capability, and so forth. The development of a joint plan requires prediction and models to translate logistics process performance and resource levels to operationally relevant measures of effectiveness for the plan. Draft plans are iterated until a feasible plan is generated. These feasibility assessments require models and predictions to determine if assumed logistics process performance and resources allocated to the plan can meet desired operational effects. To support rapid global deployment and employment objectives, the Air Force has geared deployment so that fewer resources are deployed with combat units, requiring less material to be initially deployed and therefore allowing more rapid deployment of the unit. The Air Force then relies on responsive resupply to support ongoing operational activities.
- Establishment of logistics process performance and resource-level control parameters that are necessary to achieve the desired operational objectives.
- Execution of the plan and tracking of control parameters against actual process performance and resource levels to achieve specific operational effects. This is the sense part of the CSC2 system. The system senses when deviations in logistics system performance will affect operational performance. This is critical to military activities. Many subsystems may not be performing as well as they could, and yet their performance may not affect operational

outcomes. The system must be able to differentiate between insignificant degradations in performance and CS shortfalls that will constrain operations.

- Signaling logistics process owners when their processes lie outside control limits. When logistics performance is likely to adversely affect operational outcomes, action is necessary to correct the process performance or to adjust logistics resource levels to conform to the actual process performance, e.g., if transportation is slower than planned, additional resource levels at the deployed location may have to be authorized if transportation cannot be made quicker, as may be the case in high-threat environments. Prediction capabilities are critical here, because the aim of S&RCS capabilities is to identify CS problems *before* they have a negative effect on operational objectives.
- Replan logistics or operational components of the plan to mitigate the portions of the plan that are outside control limits. This affects the plan and new control limits will need to be established and the process of tracking performance continued. This sense and respond (S&R) system then continues indefinitely.

Modern CSC2 capabilities, as well as future improvements, can be used by the Department of Defense (DoD) and the Air Force to build an efficient system of S&RCS in and among the military services. More significantly, today's emerging CSC2 capabilities are facilitating the move to S&RCS. In the past, limits in CSC2 have prevented a robust and systematic S&RCS capability. Today, a convergence of CS doctrine and capability makes S&RCS possible. These new capabilities will allow the Air Force to translate operational requirements into logistical requirements, set control parameters, sense, and respond to out-of-control conditions. In short, the Air Force can achieve S&RCS capabilities in the challenging military environment if it continues along the path of upgrading the CSC2 architecture, information systems, organizations, and training of CS personnel. (See pp. 20–27.)

Technology Necessary to Create S&CS Capabilities

The DoD Office of Force Transformation (OFT) developed the military sense and respond logistics concept, borrowing heavily from research in the commercial sector (which was in turn indebted to earlier military efforts) to describe an adaptive method for maintaining operational availability of units by managing their end-to-end support network.[1] OFT identified a number of technologies that are needed to produce an S&RL capability, two of which were highlighted as especially important components: radio frequency identification (RFID) and intelligent (adaptive) software agents. RFID is an Automatic Identification Technology (AIT) that provides location and status information for items in the CS system. RFID technologies are fairly mature and have been fielded in both commercial and military arenas.

Agent-based modeling allows a more robust simulation of combat support operations. Agent-based models (ABMs) have been used extensively in combat modeling but, until very recently, there has been limited application in the logistics area. A number of initiatives developed by the Defense Advanced Research Project Agency have examined the use of ABMs in the CS domain; however, these technologies are still in their early stages.

This monograph summarizes a number of key DoD and commercial initiatives to implement S&RL technologies and identifies a promising DoD trial (OFT's S&RL Information Technology prototype) along with one successfully fielded commercial system (developed by General Electric Transportation Systems). However, an important conclusion of this review is that although current technology has enabled a limited set of sense and respond capabilities, a full implementation of S&RL concepts remains dependent on substantial future technological development. The largest challenge ahead for implementing a broader S&RCS capability is the development of an understanding of the interactions between combat support system performance and combat operational metrics. (See p. 37.)

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1 U.S. DoD (2003).

An Implementation Path for Creating Air Force S&RCS Capabilities

The Air Force has already begun to take steps to implement some of these concepts and technologies with varying degrees of success. Air Force implementation actions include making doctrine changes to recognize the importance of CSC2, as part of S&RCS capabilities, and identifying training and information system improvements.

In addition, the Air Force should identify one organization to lead development of CSC2 and associated S&RCS capabilities. This would facilitate the development of these capabilities. Currently, the Air Force Command and Control Intelligence, Surveillance, and Reconnaissance Center (AFC2ISRC) is tasked with developing and testing C2 tools. The AFC2ISRC has an A4 (logistics) staff element that could exercise responsibility for developing and leveraging existing CSC2 and S&RCS tools under the AFC2ISRC charter. This lead role would need to be supported by the AFC2ISRC/CC and A4/7 (formerly AF/IL) and the AFC2ISRC mission statement might need to be revised to emphasize the importance of the CSC2 and S&RCS development responsibility. Staffing levels to accomplish the new responsibilities may need to be reviewed to ensure that they are adequate to handle the added responsibilities. (See pp. 71–72.)