SENSE AND RESPOND LOGISTICS: IMPLICATIONS FOR THE UNITED STATES AIR FORCE

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ABSTRACT

In the past, *prediction* and *responsiveness* have been viewed as competing concepts within logistics. Early military supply systems operated primarily on a "push" concept, emphasizing improved prediction of future demands. Recent military logistics research has focused on the "pull" concept, emphasizing responsiveness that requires guaranteed communication links and rapid transportation capabilities. This study develops a complementary view of prediction and responsiveness capabilities, demonstrating that robust military logistics capabilities require both. We identify recent technological developments that enable pieces of such a sense-and-respond capability, discuss how these technologies might interact with existing military systems, and provide recommendations for future research and development emphases.

INTRODUCTION

The inefficiencies of the military logistical system in the early 20th century spurred a modern scientific study of logistics. Most of the early military supply system operated on a "push" concept rather than in response to actual needs. Such a system emphasizes the prediction of future demands, with predefined supply packages transported to operational units on a scheduled basis. It was thought that having an abundance of resources in theater ensured that combat support (CS) elements would be able to provide everything needed to achieve operational effects. In practice, the presence of "mountains of supplies" did not always assure that war fighters' demands were met. In fact, the backlog of war materiel congested the CS system due to inefficiencies in the transportation system and the prioritization processes. It was evident that there was a need for a more comprehensive capability for controlling CS assets in response to actual war fighter needs.

U.S. military logistics planning grew even more difficult with the collapse of the Soviet Union and the dissolution of the associated threat to U.S. interests in Europe. For while the previous CS system was inefficient in its use of resources, it was at least focused on (presumably) known geographic locations and specific threats. Today's geopolitical environment is defined not only by a number of regional powers, but also by nontraditional security threats. The uncertainty associated with planning for military operations thus extended to include incertitude with respect to the *locations* and *purpose* of operations.

SENSE AND RESPOND COMBAT SUPPORT

The shift to a more expeditionary force compelled a movement within the Air Force toward an Agile Combat Support (ACS) capability. This ACS view focuses on the large set of CS processes needed to both initiate and sustain Air Force Expeditionary operations, encompassing two major activities:

1. Those associated with establishing and supporting forward operating locations (FOLs).
2. Those associated with maintaining the weapon system availability needed to meet Combatant Commander (COCOM) operational requirements.

Because no combatant commander possessed all of the logistics resources needed to initiate and sustain combat operations, an emphasis was placed upon capabilities to rapidly distribute (deploy and sustain) resources from where they were stored or available to where they would be employed, and to control distribution of scarce resources to the units that needed them most. These actions comprised the components of a modern Combat Support Command and Control (CSC2), assessing needs and determining what is required in operationally relevant terms.

Combat Support Command and Control

CSC2 is the “central processing unit” of a CS system that coordinates and controls the ACS enterprise. In essence, CSC2 sets a framework for the transformation of traditional logistics support into an ACS capability. CSC2 is not simply an information system; rather it sits on top of functional logistics systems and uses information from them to translate CS process performance and resource levels into operational performance metrics. It also uses information from logistics information systems to track the parameters necessary to control performance. It includes the battlespace management process of planning, directing, coordinating, and controlling CS resources to meet operational objectives [1]. The objective of this CSC2 is to integrate operational and CS planning in a closed-loop environment, providing feedback on performance and resources. The C2 of modern CS assets must be an activity that is woven thoroughly with operational events, from planning, through deployment, employment, re-tasking, and recuperation. Additionally, CS goals and objectives must be increasingly linked directly to operational goals and objectives, with metrics that have relevance to both war fighter and logistician.

The ability of CS forces to sense the operational environment accurately, and then adapt swiftly to develop tailored responses to the operational requirements, is essential to achieving the war fighters’ objectives and effects effectively and efficiently. In the CS enterprise, the goal of sensing and adapting quickly is to ensure an uninterrupted flow of critical CS materiel to the war fighter, arriving when and where he or she needs it. Deploying mountains of *just-in-case* supplies is no longer part of modern CS strategy. However, a purely *reactive* system that intervenes only *after* logistics problems inhibit operational plans does not offer much benefit to the war fighter. A *proactive* system is needed that *monitors* logistics system performance, *analyzes* current system data to predict constraints (both near- and long-term) that the CS system will place upon operational objectives, and *identifies mitigations* that can be taken to minimize the impact of these constraints, demonstrating a Sense & Respond Combat Support (S&RCS) capability.

Current Status of the Necessary Technologies

The Department of Defense (DoD) Office of Force Transformation (OFT) has attempted to develop a unified concept for military Sense and Respond Logistics (S&RL)[3]. Two important technologies that OFT identified as necessary to enable an ultimate S&RL capability are Radio Frequency Identification (RFID) and intelligent (adaptive) software agents. RFID is a method of identifying unique items using radio waves that is currently fielded in both military and civilian applications. Typically, a reader communicates with a tag that holds digital information in a microchip, although there are chipless forms of RFID tags that use material to reflect back a portion of the radio waves beamed at them. RFID allows for enhanced visibility of items in the supply chain, enabling commanders to see the location and levels of their inventories in real-time. Software agents are autonomous and adaptive computational entities that interact with other agents and exhibit complex social behavior, whereby one agent may attempt to “persuade” another agent to execute a particular function. Agent Based Models are already in wide use within the DoD for force-on-force simulations, but have only recently been adapted for military logistics use. Although some simple supply chain simulations have been done for logistics, few have modeled actual organizations with the requisite detail necessary to gain insight into alternative policies.

In recent years, many researchers have tried to implement pieces of an S&RL capability into military systems. Most of these applications have focused on either reactive logistics systems that manage observed problems, or improved tools for logistics planning. An application which demonstrated some of the proactive characteristics associated with S&RCS was the *OFT S&RL Information Technology (IT) prototype*. This prototype was first used by the Air Force Materiel Command's (AFMC) Predictive Support Awareness program, which sought to optimize the AF supply chain with one end anchored to AFMC and the other directly to the war fighters in the field, in an attempt to improve both the prediction of logistics needs and problems as well as the resolution of problems in advance of their identification by end users. This prototype presented a "state-of-the-possible" demonstration of core technologies within an S&RL system, tested in a somewhat realistic (but still very limited) scenario.

While many commercial firms write about S&RL capabilities, we identified only one fielded application of a proactive commercial logistics system. Expert-on-Alert is a software application developed by General Electric Transportation Systems for its locomotive engine business [4]. This system is designed to diagnose engine problems before they result in "road failures", i.e., locomotives that are stranded on the tracks away from maintenance facilities. The system continuously monitors locomotive parameters and transmits this data to a centralized database. Automated diagnostics tools use rule-based techniques to screen the data for events that require maintenance intervention, and as trends are recognized in the data, the diagnostics tools are updated to reflect new system knowledge. Experienced maintainers at the service center review the repair recommendations, which are delivered automatically to the locomotive within 30 minutes of problem detection. The system then notifies the appropriate repair facility allowing for advance coordination of maintenance parts and labor.

THE ROAD AHEAD

The Expert-on-Alert system predicts the failure of an engine based on observations of a physical system. The mechanical workings of an engine are much better understood than the interactions between the diverse actors that influence the performance of a complex logistics system. Yet even an understanding of the logistics system is not in itself adequate, since the goal of S&RCS is to tie logistics system performance to operational goals and objectives. Thus, the largest challenge ahead for implementing an S&RCS capability is developing an understanding of the interactions between CS resource levels and operational metrics. Only with this understanding can the necessary prediction capabilities be fielded.

Without the proper metrics for measuring the agent (and other) technologies required for S&RCS implementation, it is difficult to project where or when CSC2 effectiveness stands to best gain from this technology insertion. The majority of experts believe that a medium-term vision and commitment of 4-6 years is sensible for the development of relevant core technologies. However, it should be noted that this capability is not only applicable to new weapon systems. The implementation of a robust S&RCS capability will require the insertion of autonomous technologies on some judiciously chosen existing weapon system platforms, necessitating extensive and costly retrofitting. The benefits accrued through this concept must be closely weighed against these retrofit costs on both a system-by-system and a total capability basis.

REFERENCES

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