C4ISR: EFFECTS-DELIVERY BASED COMMAND AND CONTROL
USC INSTITUTE FOR CREATIVE TECHNOLOGIES

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ABSTRACT

This project describes a command and control system that combines key features of hierarchical command and control with the flexibility and adaptive response capabilities of information rich networks and adaptive human decision-making.

1. INTRODRUCTION

This system focuses on maximizing situational awareness and the control of effects available to individual soldiers in the field. The latter point is critical for mission success yet does not appear to be a feature of any other command and control system in development. The Effects Management concept being proposed is designed to make all leaders and field operators vastly more successful by improving speed, tactical mobility and precision, as well as dramatically reducing problems and errors (e.g., lack of appropriate weapon systems, friendly fire). The system is modular and scaleable and many of the components are either in development or will soon be technologically feasible. The primary system modules are the CLIP (Combat Logical Inventory Process), the Effects Manager (EM), and the Information Manager (IM).

2. SYSTEM MODULES

To supply forward ground forces with more rapid response capability requires a streamlining of the process by which situational awareness is shared with command nodes. The CLIP serves the individual soldier as a mobile staging and operational platform within the larger C4ISR architecture. At any time during an operation potential targets can be identified and queried. The CLIP interface accepts data regarding target location, movement and affiliation, and filters it through the IM global model. The IM can reference friendly force locations, request more information, and suggest pertinent courses of action to the operator (OP), who then decides how to act. The CLIP can also be used to modify the effects limit of the unit in the field, and the mission parameters, if these actions are warranted. At the command level, the CLIP architecture allows for more rapid and efficient, deployment of forces by helping Objective Leaders (OL) parse the necessary tasks for OP teams to complete. System recommendations regarding availability, capability and even probability of mission success help to more quickly form shared situational awareness (SSA) among OLs. This represents a step toward realizing the ultimate goal of consistently getting the right people to the right place at the right time. Several decision support system architectures specifically tailored to serve command and control needs have already been developed (Rose, 1998; Arnborg, 2000; Brynielsson & Granlund, 2001). The CLIP thus functions as an operational interface and tactical "organizer" for both the individual leader and the soldier.

The primary function of the Effect Manager is to assist the soldier in determining the resources (effects) available to him. Effects are primarily munitions options, but can include transportation, sensor, or even communication support and deployment. The software will invoke the model of a credit card, where users have limits to the effects they can access. When a soldier makes a request, the system considers his clearance level (credit limit) and effects availability, simultaneously updating the IM global model with current effects status in order to de-conflict targeting. The soldier is also updated on effects status. In the case of a long distance delivery (of munitions) this may include effects intercept warnings and time on target indicators. Effects delivery "purchases" are logged by the computer, which can assist command in determining the future maximum "purchasing power" (credit limit) of the soldier.

The EM software is conceived in large part as a knowledge management application. Its primary interface concerns physical inventory tracking yet it must also manage the "account" of everyone who has access within a given operation. It will also track the choices of individuals and the outcomes of those choices for potential modifications to access levels in future operations. Systems like the Army's Adapa and AKO are useful models. Acting much like a project budget, single point of entry sub-networks, connected to the global IM but dedicated to a given operation, would help economize resource use. These "temporary" accounts maintain the lifespan of an operation, and once expired, can be added to the IM historical database to serve as reference modules for later actions. Much of the functionality of this software is dependent on tracking ability, particularly speed and identification of an effect's allocation (reserved, spent, available). Combinations of sensors, radio-frequency ID tags (RFID) will identify and monitor any friendly soldier. A unique signal emanating from the tagged unit can be fed to the local, mobile ad hoc network (MANET) and tracked by the IM to update the global model. If the signal is piggy- backed on the Joint Tactical Radio System every solider can act as a transmitter. Mobile Ad Hoc Networks provide an excellent option for the hardware that such a system will need to function. Recent work by Gerla et al. (2002) on the development of a Landmark Routing Protocol (LANMAR) for Large Scale Ad Hoc Networks suggests that the speed requirements of effects requests can be met in the future. The system will also be resistant to disruption through its ability to reroute information packets. Such a system will be a boon to red force tracking as it could manage numerous sensors. Technologies that will support the CLIP system, as well as the EM are under development by CECOM Research, Development and Engineering Center (RDEC).

The IM has the dual ability of maintaining an accurate model of real world events, and of suggesting determinations about the probable outcome of a given manipulation within that model. This approach eliminates many of the problems faced with traditional automation by utilizing mechanical processing speed while maintaining system flexibility and human in the loop (HITL) decision-making (Endsley & Kiris 1995, Kaber et al., 1998, Endsley and Kaber, 1999). It also helps minimize the need for time consuming parallel communication structures within teams. Instead, a serial pattern is favored, thus improving relevant shared situational awareness (Artman, 1999) among OLs and OPs. The primary activities of the IM are the formation of the common operating picture (COP) and common relevant operating picture (CROP), target de-confliction, and information brokering. Creating the COP requires the examination of massive amounts of incoming data. The ability to transform this data stream into a CROP for a given objective involves prioritizing and sorting through less important details, to *push* the most crucial aspects to the surface at any given moment. This approach streamlines the decision process by allowing the attention resources of the OL to be more efficiently used. A COP can be fused with historical referents or even simulation outcomes to create a database from which the OL can *pull* more information if the CROP is found to be lacking. The architecture for pattern recognition programs already exists in a variety of forms. This piece can serve as a modular plug-in to the IM backbone discussed above. The IM can also be viewed as a planning tool for large-scale operations where time constraints are less immediate.

As other forces in the world gain access to technologies that are similar to our own, the likelihood for continued success in the field will depend on a commander's ability to rapidly and seamlessly make real-time changes as contexts shift and evolve. Dynamic, adaptable, peer-to-peer collaborative networks with scalable reachback effects will greatly enable a new generation of soldiers and leaders to engage diverse and capable future enemies.

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