Future Army Tactical Operation Center Concept

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Abstract

The inefficiency, high complexity, and lack of mobility of current army tactical operation centers (TOC) will limit their effectiveness in the highly dynamic non-linear future battlefield. The extensive hardware, software, and manpower resources needed to operate a current TOC severely restrict the mobility envisioned for the future battlefield. There are three major technical thrusts required to provide this drastic increase in automation; system architecture unification, integrating airborne, satellite, and terrestrial communications, and the development and maximum usage of software agent architectures and applications. The Army is working aggressively in each of these areas. A common client server and database architecture is being developed for the Army Battle Command System. Robust wide band radios and networks are being developed and experimented with. There is significant research, development and implementation of agent architectures and applications that apply to this battlefield automation. This paper focuses on both the challenges of this battlefield TOC automation and a proposed agent based solution.

Introduction

There is a strong sense of dissatisfaction in the design and functionality of current tactical operation centers (TOC). This concern is caused by the inefficiency, high complexity and lack of mobility of these centers. The mobility issue refers both to the inability to operate on the move as well as the long set up and tear down time when transitioning between stationary and mobile operations. The extensive hardware, software, power, and manpower resources needed to operate a TOC and the current dependence on terrestrial communications severely limit the mobility needed for the now and future battlefield. Because the future battlefield is anticipated to be much more dynamic and non-linear than current operations, these problems will be exacerbated. The TOC exists to support the tactical commander in understanding the current state of the battlefield and predicting its future state. This comprehension enables rapid and effective decision making and leadership in the battlespace. The TOC must also be able to project its critical information to a remote commander who is frequently in a platform such as a tank or helicopter either enroute or observing a critical portion of the battlefield. The TOC is the information and control center of the tactical battlefield. Sensors and other resources are tasked, and an enormous amount of information is rapidly gathered and fused from a multitude of sources (local and remote sensors, maneuver platforms, forward observers, and scouts). Operational plans are developed, refined, and disseminated for execution. These operations are monitored and reactive planning is initiated. Therefore the TOC is a critical, highly responsive node of a widely distributed and mobile force. This paper attempts to define the software agent technology and visualization required to evolve the current TOC state into the efficient highly mobile system envisioned in figure 1. Current brigade TOC's are implemented with 16 workstations and the manpower to continuously operate them. This mobile TOC concept envisions operating with 4 processing nodes.

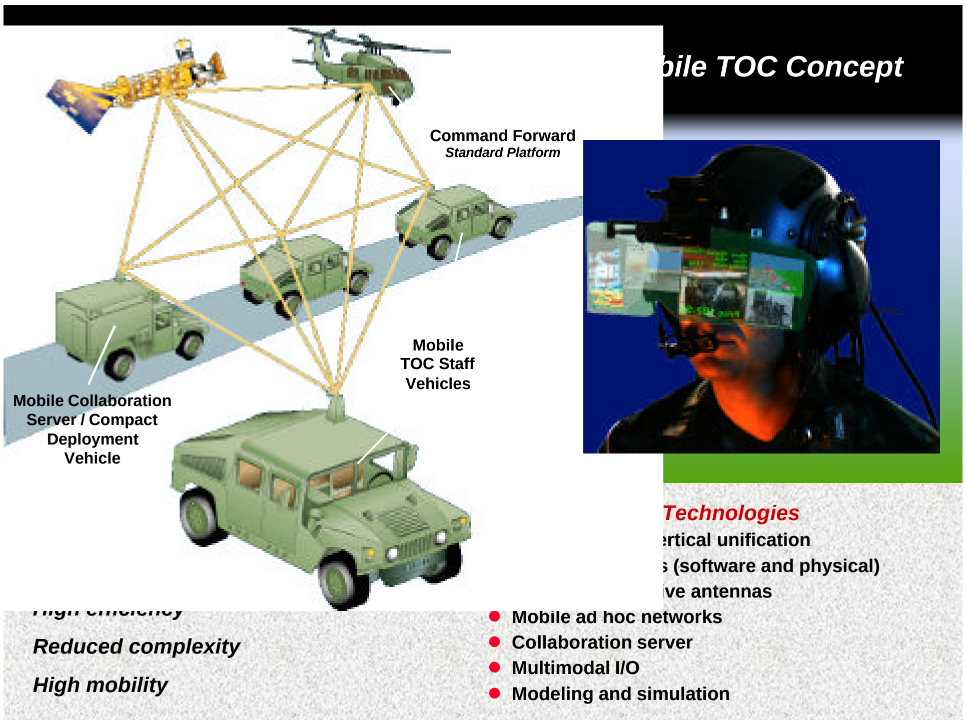

Figure 1: Future TOC Concept

There are three major technology areas that must be developed and applied for this evolution to be fulfilled: system architecture unification, enhanced telecommunications, and software agent architecture and applications. This paper will not address the telecommunications issue other than to note that the army is moving away from total reliance on a low bandwidth VHF terrestrial link, to a broader bandwidth multi-modal approach including airborne and satellite links, for these lower echelons. The current Army Battle Command System (ABCS) is composed of six complex, interoperable, albeit independent systems which provide the functionality and connectivity for a specific functional area. These systems provide the core command and control functions for the current battlefield functional areas which are: intelligence, maneuver, air defense, fire support, and combat service support. There is a potential enormous gain if these systems could be unified enough to become a single albeit still modular system (by taking maximum advantage of all redundancies and synergism in architecture, infrastructure, and applications). This systems unification would significantly reduce maintenance and training cost and enhance cross-functional battlefield functional area operation. This systems unification is only possible if its major system components such as database, visualization, and agent architectures are sufficiently scalable, extensible, and adaptable. This would lower the need for custom approaches for each functional area. The ABCS is already moving toward a common database and client/server architecture (figure 2) eliminating some of its custom approaches.

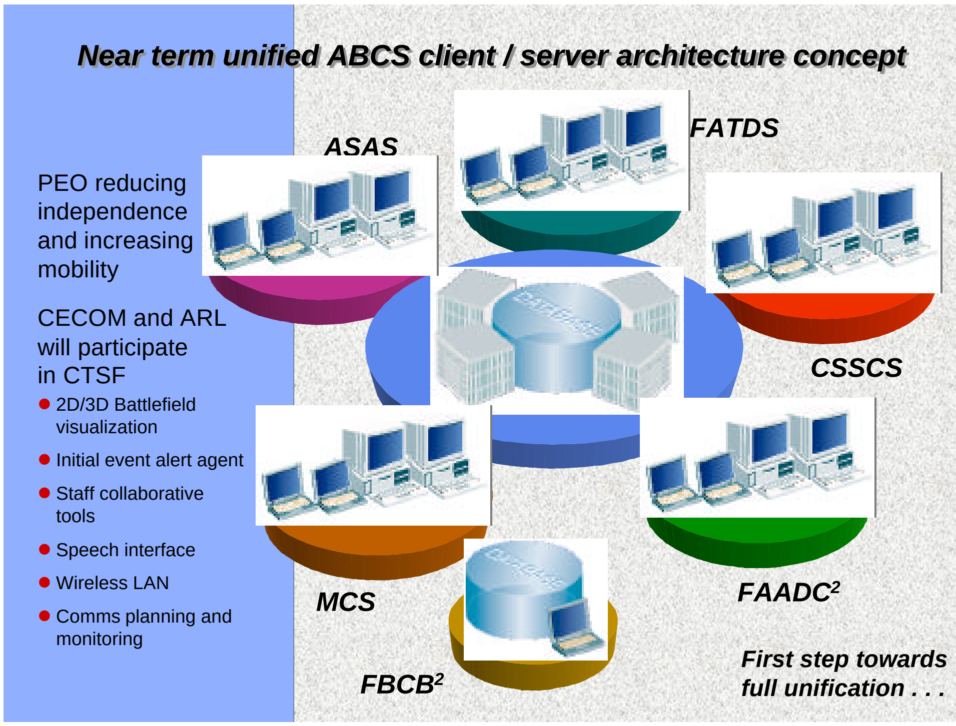

Figure 2: Near Term ABCS Architecture

Visualization/agent architecture

The next step (after consolidation to a single system) to significantly increase efficiency is to develop a scalable, extensible, and adaptable software agent architecture. Visualization and software agent thrusts are closely linked because much of the data the agents will analyze is the same that is being visualized and the information the agents generate will need to be visualized. Also this visualization approach will be used as a mode to enhance the human/agent interaction as well as to visualize their status. To reach the efficiency needed, most low level information retrieval, dissemination, monitoring, alerting as well as higher level analysis applications will be performed or controlled by these agents as illustrated in figure 3.

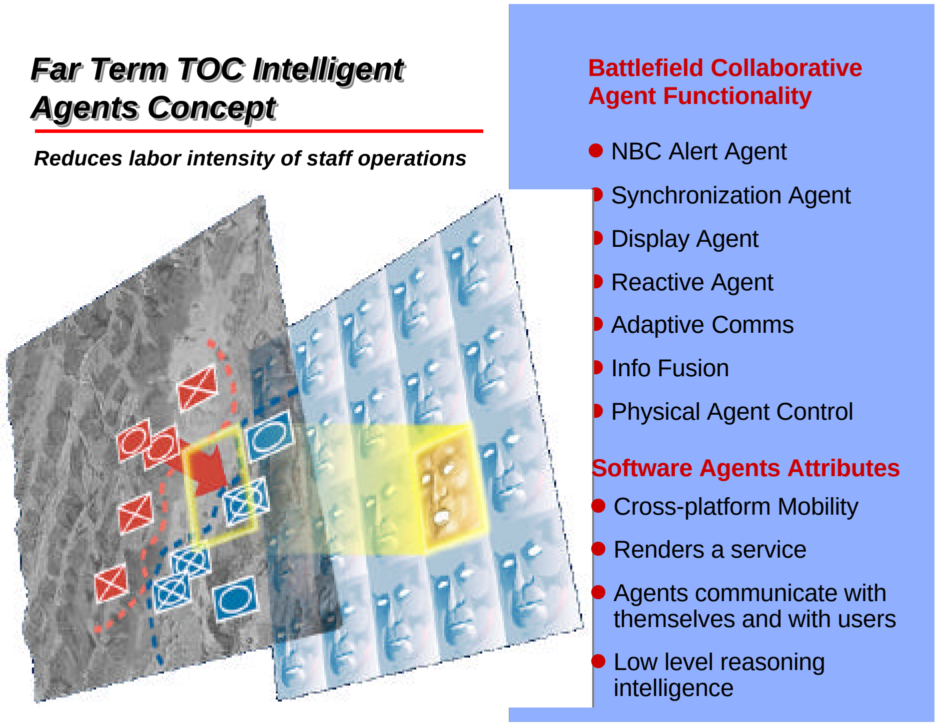

Figure 3: Visualization and agents dependency

Most of the current emphasis of the battlefield visualization program is on providing a global multi-resolution infrastructure with the ability to visualize the entire battlefield (terrain, weather, entities, features, communications, etc.) at whatever resolution data is available. This enables the commander to have his custom global view of the battlefield as well as any high-resolution local view to support critical decisions. This same infrastructure supports high fidelity local views for the platform commanders as well as the ability to jump to any other local view in the world to support training or preparation for deployment. The proposed agent architecture will similarly need to support global as well as local commanders and perform analyses on multi-resolution data. Examples of these requirements will be presented in the application section. It should be noted many of the agent applications would also need to address and display uncertainty.

Applications

There are myriad possible significant battlefield agent applications, however this paper will focus on one that requires scalability and extensibility of the agent approach. The distributed tactical operation center and platform interaction will define the scalability requirements and the intelligence, maneuver, and logistics functionality will define the extensibility requirements. Consider the following scenario. The TOC brigade commander has selected a maneuver course of action plan, illustrated in figure 4, that calls for the synchronized movement, enemy engagement and logistics resupply of his three battalions. The plan has been disseminated and the maneuver platforms have begun executing this course of action. This simple plan implementation stimulates significant agent activity both in the TOC as well as in the maneuver platforms. A global maneuver plan monitor agent in the TOC interacts with the maneuver synchronization monitor agents in the platforms. The platform synchronization monitor agents have the task of alerting the human platform commander if the maneuver entity is not able to execute its maneuver plan. This agent would also alert the TOC maneuver monitor agent of any execution problems. An intelligence agent continuously monitors and retrieves any pertinent enemy information that would effect this operation. For example, an enemy radar is detected near the planned path of one of the maneuver battalions. This intelligence agent alerts both the TOC maneuver plan agent as well as the affected platform agents (maneuver and intelligence). At the TOC a fire support agent generates an attack plan to disable this enemy sensor asset. This plan is presented to the TOC commander and is refused because of lack of available fire support assets. At the affected platforms a reactive maneuver plan is generated and if acceptable to the local commander is executed. A platform logistics monitor agent is keeping tract of local resources (fuel, ammunition spare parts, etc.) and disseminates this information to the TOC logistics agent. The TOC logistics agent continuously monitors the resupply plan that supports this engagement plan. If the resupply points become inadequate because excessive engagement times or maneuver, the TOC logistics agent replans the resupply points. This example application indicates a need for monitoring, alerting, dissemination and retrieval agents for each of the major functions such as maneuver, intelligence, and logistics to exist both at the TOC and the lead platforms. Figure 5 illustrates a proposed agent application architecture for the tactical battlefield. There are obviously a wide range of applications within each of the functional areas. Also the set of applications within a functional area such as maneuver differ at the TOC and the platform. Because of the complexities inherent in creating and directing a large set of agents, it is essential that the human/agent interaction be as intuitive as possible. Considering that many agent applications will be oriented to objects in the battle space, a strong battlefield visualization approach would be essential.

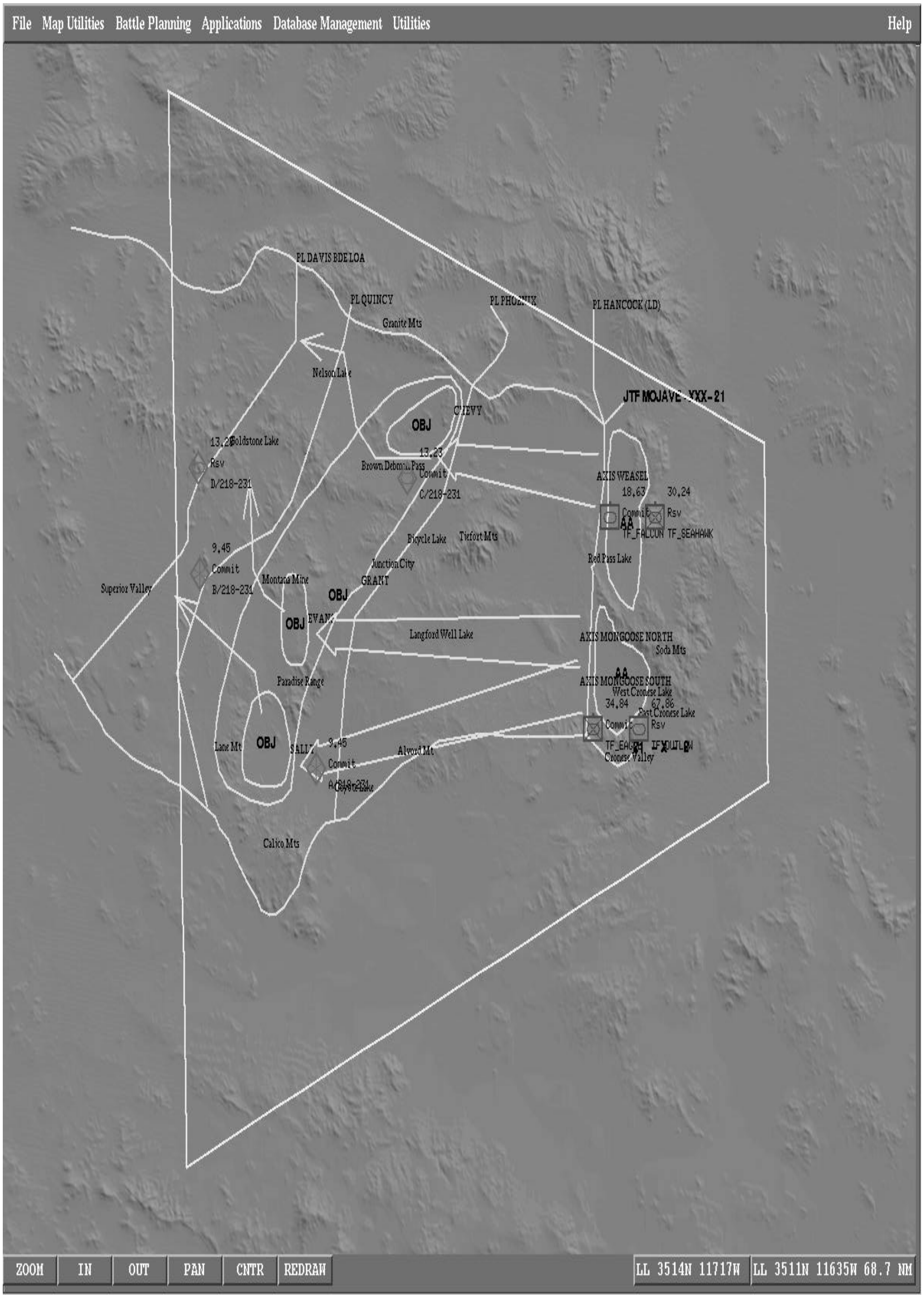

Figure 4: Maneuver Plan

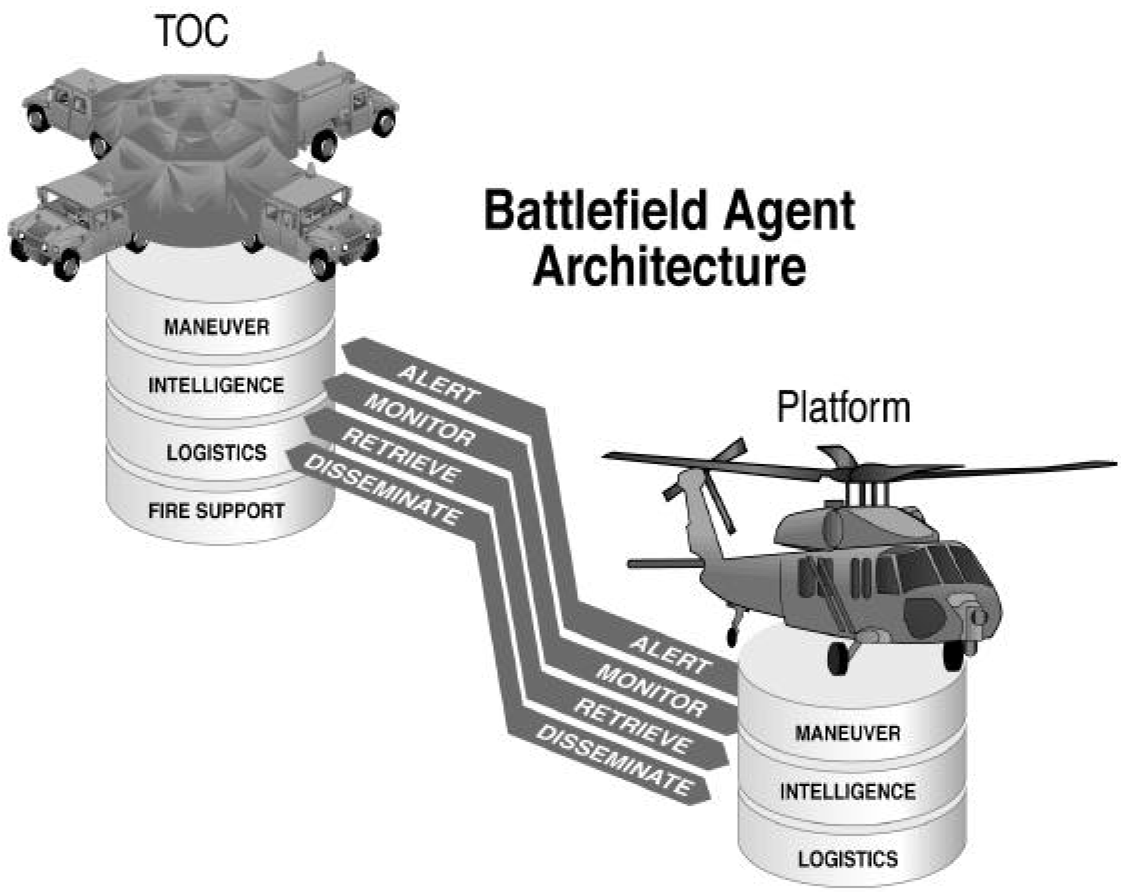

Figure 5: TOC Agent Application Architecture

Conclusion

A relatively simple agent application architecture may be sufficient to perform many of the manpower intensive tasks both at the TOC and the individual platforms. These tasks have been categorized similarly to the battlefield functional areas. Although there are myriad applications that span a widely dispersed level of complexity, there are a number of low level applications that can be very effective in TOC automation. It is critical that the agent approach be scalable, extensible, and adaptable to address the broad application area of the tactical battlefield. Many of these tasks can be implemented with generic low level monitor, alert, retrieve, and disseminate functions. There still is concern that the human agent interaction may be too encumbering for the commanders and staff involved. Closely coupling the agent interaction with battlefield visualization should make the interaction more intuitive, also an embedded training application for decision making that utilizes this agent approach will accelerate the acceptance of this agent approach. This embedded training would include the ability to rapidly construct scenarios to continuously improve the commander's and his staff's decision making. By embedding this capability the operators will inherently train on the utilization of this agent approach.