DARPA's Advanced Logistics Program

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I am impressed with the effort and cooperation shown by this diverse group over the past several months as you have tried to define and articulate the research agenda for the intermodal industry. The task becomes increasingly complex because of the vastness of intermodalism and its impact on all sectors—commercial, government, and military. I would like to present a view of the future from the Defense Advanced Research Projects Agency (DARPA) perspective—not what the U.S. Department of Defense (DOD) logistics will look like in the next few years, but a view of where it ought to be a decade or two decades from now.

DARPA is a DOD agency that is and always has been strongly focused on military capabilities. Although this was recently reemphasized by the Congress, by once again changing the name from Advanced Research Projects Agency to Defense Advanced Research Projects Agency, the agency has never waivered in that respect, only the name has changed.

DARPA's mission is to develop imaginative, innovative, and often high-risk technology and systems for the military that offer a significant military impact. And they must go well beyond the normal evolutionary developmental approaches. DARPA is beginning a new program this year that focuses on logistics and the complex problems of projecting and sustaining combat power.

The Challenge

The logistics challenge for DOD is summarized by Figure 1. Since the end of the Cold War, our national security strategy has shifted from a force that is forward deployed to a force that is domestically based and must respond to operations anywhere in the world on short notice. As a result the demands on our logistics systems have increased dramatically. As a nation we must be able to project and sustain overwhelming combat power sooner—in other words, put the right stuff in the right place at the right time with full knowledge that our inventory of supplies will be smaller.

Logistics is a critical problem to the military because the current approach is to overwhelm the problem with brute force. In doing so we must incur an enormous expense, which can no

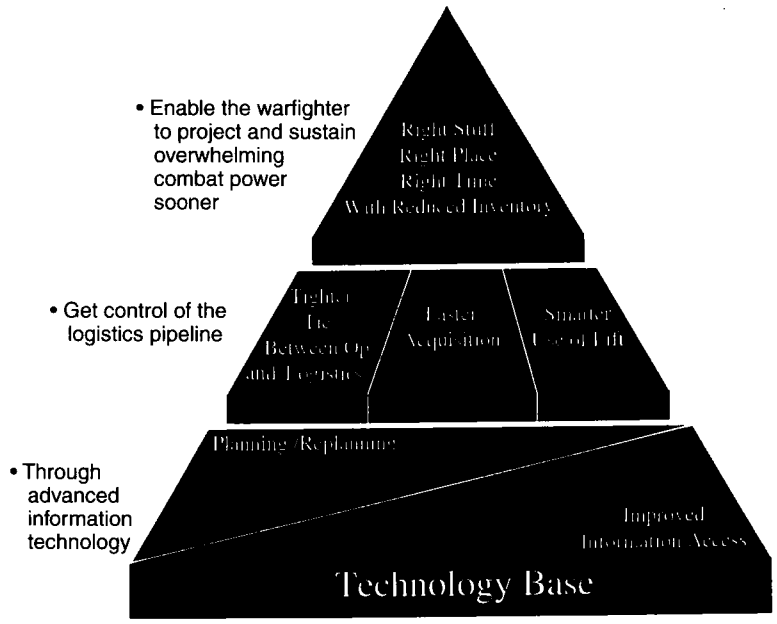

FIGURE 1 The logistics challenge for DOD. (*source: DARPA*)

longer be tolerated. Therefore, we *must* get control of the logistics pipeline. I have set that as the number one goal of our program. We must have tighter ties between operations and logistics, acquire material faster, and make smarter use of lift.

The only way this can be done is through aggressive development of advanced information technology systems; this will cause a fundamental change in the way logistics planning and operations are conducted today. Simply stated, military logistics is far and away an information-system problem.

Generally, I do not see research (as we use the term at DARPA) as needed in the logistics area. Research done more generally for information systems is adequate and applicable; although almost surely there are exceptions. What is needed is the application of modern information technology and techniques within the context of a solid system design and architecture. There also must be agreement and adaptation to achieve protocols and standards, and it is essential that these be compatible with the nondefense equivalents in the civilian intermodal system. That military system design must enable and encourage maximum use of commercial capabilities through TRANSCOM and the Defense Logistics Agency (DLA).

The major impediments are as follows:

1. The sampling rate is not high enough to allow a clear enough assessment of what is happening within the logistics pipeline system to permit a closed-loop approach—in other words, monitoring;
2. Practical monitoring is not feasible in combat or crisis surge situations—for example, at a beach head. This is particularly troublesome for DOD, since the surges are likely to take place under conditions when proscribed procedures and rules are lost to the press of combat or crisis.
3. We are not yet able to create interoperability with a large variety of existing and planned systems and data bases.

The papers by John King and Jacques Gansler raise a number of important issues (many of which involve policy decisions) and also include practical problems that must be studied and dealt with.

The Warfighter's Logistics Problem

Figure 2 shows the amount of material that was moved as part of Desert Shield and Desert Storm—over 3.5 million tons of materiel to southwest Asia. This was roughly the equivalent of moving the entire city of Atlanta (the people, all their food and belongings, and cars) halfway around the world. However, we had time to prepare, and the lift was conducted under favorable conditions. We had unopposed transits, host nation support, the best port facilities in the world, and we used foreign flag shipping .

Even so, this was an inefficient operation. Innumerable things were lost in the sheer quantity after arrival, or reported as lost because the user did not know whether it was en route, and were sent again—and again.

Today our strategy calls for the capability to conduct two large operations almost simultaneously. And the time to respond is significantly shorter. In short, we must move the mountain to the left, know where everything is so the summit is lower but equally effective, and do it twice. If this scenario occurs, the U.S. transportation infrastructure and our strategic mobility assets will be severely taxed. To meet this stressing requirement, logistics and transportation assets must be deployed, tracked, refurbished and redeployed more efficiently than ever before. In this era of downsizing, DOD will become more and more dependent on commercial intermodal transportation.

Background

If we are to gain control of the logistics pipeline, we must have complete control of the logistic information that runs it. To illustrate, we conducted a detailed analysis of Desert Storm logistics movement to test the impact of advanced information systems (Figure 3). We determined that the operation could have been shortened by 100 days and the amount of material shipped could have been reduced by 1 million tons. By so doing we also could have avoided spending over $650 million dollars in transportation costs alone, let alone the cost of materiel. The lack of quality and timely information led to just about every logistics problem encountered.

Two most noteworthy findings are:

1. Overall sequencing of unit moves was not orchestrated. The same required-delivery date drove all units to close (or try to close) at the same relative time frame. The resultant queues and chaos became a great disruption to the deployment and in theater support capabilities.
2. The actual material shipped grew in size without anyone's knowledge and certainly without any tools to predict the eventual impact. This caused a considerable waste of shipping resources and led to delays that rippled throughout the deployment.

Our analysis of Desert Storm convinced us that there is a wide range of problems in deployment, redeployment, and retrograde operations caused by our inability to plan and retain visibility over what is going on relative to that plan. Had we seen the problems coming, we may have been able to take some corrective action.

What we did see in Desert Storm was what we had seen in Vietnam, and we saw it repeated in Operation Restore Hope in Somalia, and it continued in Joint Endeavor in Bosnia. In December 1995, 50,000 pieces of cold weather gear were bottlenecked at Dover AFB. There was no advance knowledge it was coming, there was insufficient documentation, and there was difficulty in coordinating actions with EUCOM. As a result, the cold weather gear just sat there.

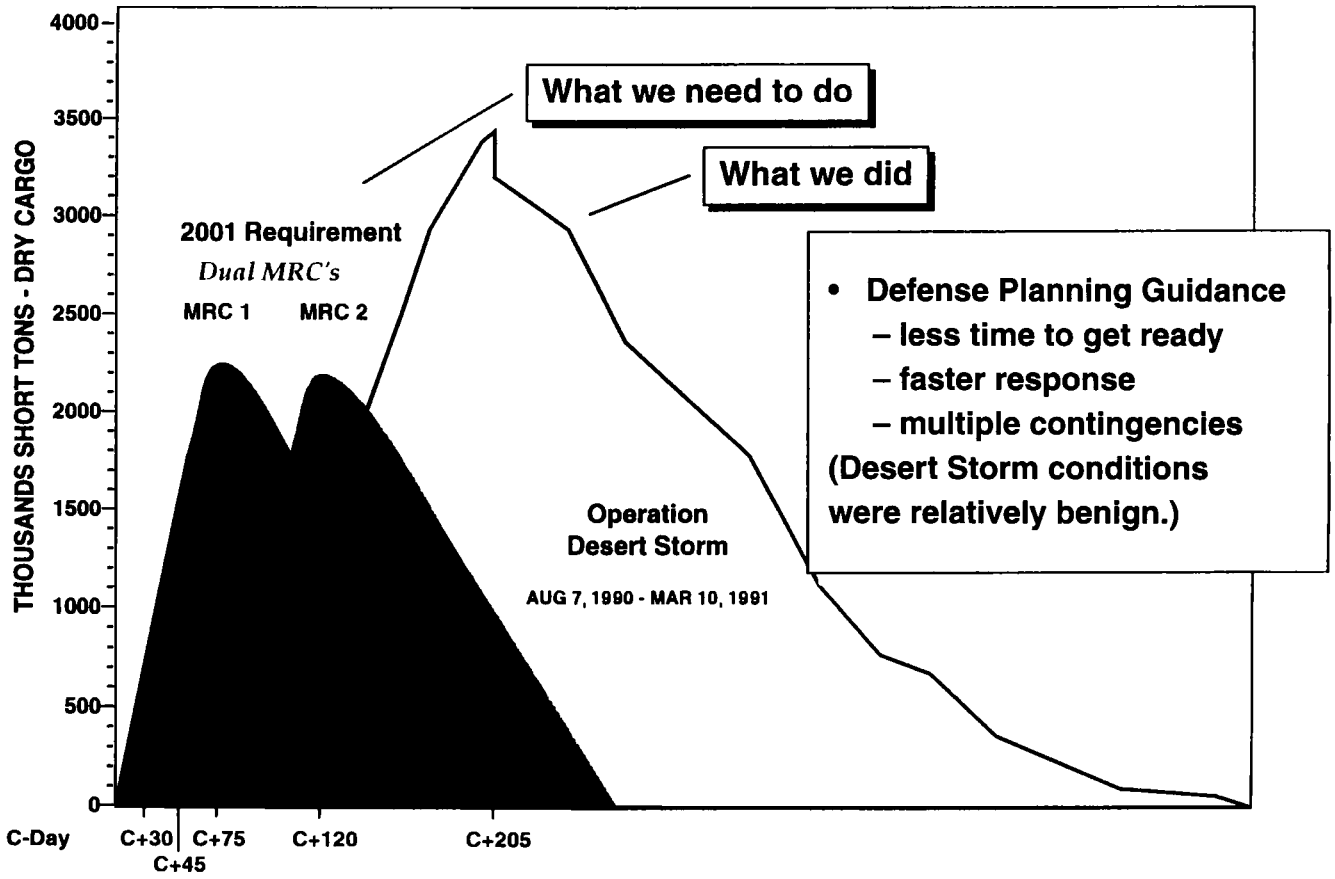

FIGURE 2 The warfighter's logistics problem, more than 3.5 million tons of materiel moved to southwest Asia as part of Desert Shield/Desert Storm. (*source: DARPA*)

Planning and Execution Today

Today's planning and execution domains remain separated. Logistics plans are developed at a high level that provides only summarized details of what the intended movement requirement may look like (Figure 4).

Planning is hampered by a serialized process. The warfighting commander delineates the overall mission and concept of operation. The operations staff (J3) outlines the alternative courses of action and the requirements seen as necessary to fight and win. Only after a lengthy series of actions to "source" the forces and resupply requirements is a plan seemingly finished. Unfortunately, it remains at the summary level. The information usually does not reflect what will eventually move.

When it becomes necessary to deploy forces, the move is almost never executed in the manner in which it was planned. When execution begins, the unit or installation or depot decides what and how much equipment and material will move. Distinctly different logistics systems are used to execute the actual movements and resupply demand actions.

There is very little real-time feedback to commanders to tell them whether there are deviations from the plan they had built. As unforeseen events begin to impact the actual movement, operators and planners cannot predict the magnitude of or the location where breakdowns in the system will occur as a result of the new set of circumstances. The planning and execution process today suffers greatly from compartmentalized systems that lack the necessary level of detail on which to make timely and accurate decisions.

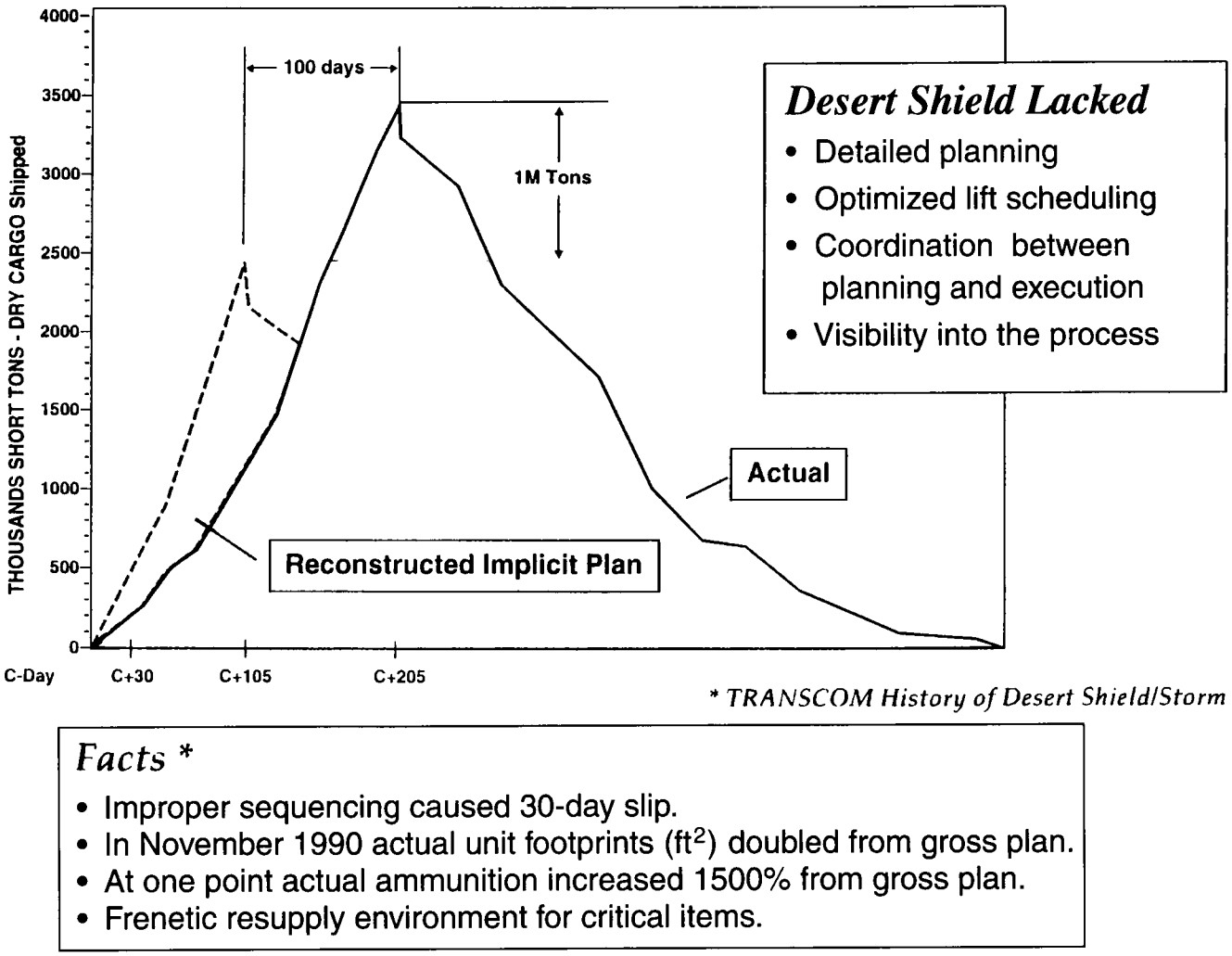

FIGURE 3 Analysis of Desert Storm logistics movement, testing the impact of advanced information systems. (*source: DARPA*)

The DARPA Program Vision

Control of the logistics pipeline demands a radical shift in the way planning and execution are done. Operations and logistics must be viewed as a tightly coupled, closed-loop system. As shown in Figure 5, the system must be a much more concurrent process in which participants work together to create a detailed plan. Operators and logisticians, at all levels, must be brought together in a distributed interactive planning environment to plan, execute, monitor, and rapidly replan.

A key element of this coordinated process will be the ability to plan in sufficient detail to execute directly from the plan. The logistics plan must be developed in consonance with the war plan and, as such, have explicit representation of the assumptions and expectations used to develop the plan.

These assumptions are critical to detecting deviations from the plan through the creation of trigger processes or "plan sentinels" that can be placed at key nodes or links in the logistics pipeline to detect deviations. "Plan sentinels" will provide the necessary closed loop feedback to maintain control of the logistics system.

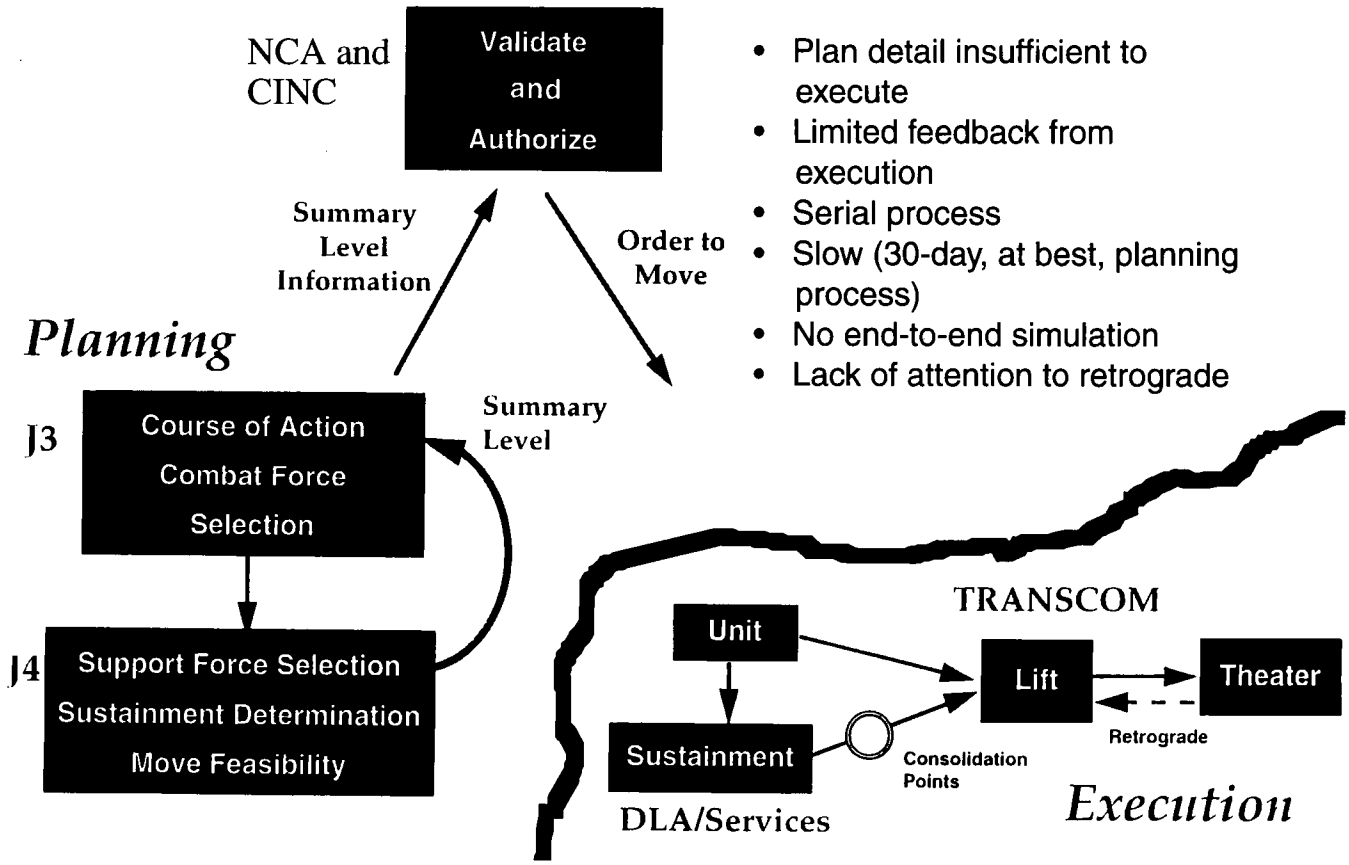

FIGURE 4 Problems with planning and execution result because logistics plans are developed at a high level. Only summarized details of what the intended movement requirement may look like are provided. (*source: DARPA*)

In the field, it is essential that the capability to know what is where includes detailed monitoring of aggregation/disaggregation processes so that the information system can track what is happening. For example, when a container is opened in the forward area, its contents must then be individually dispatched and tracked. That key set of events must be "user friendly." Soldiers in combat zones cannot be expected to manually provide accurate monitoring of these events, as we attempt today. The errors rapidly build to the point of system failure.

Combined with rapid replanning capability, sentinels provide the oversight process required to maintain a continuous loop of planning, execution, monitoring, and replanning.

Program Focus

The future concept of operations is envisioned as an interoperable environment for the operators in J3 and logisticians in J4 to coordinate their activities (Figure 6). A tightly linked J3 and J4 environment will enable the impact of logistics to bear directly on the decision-making process during course-of-action evaluations. The J4 will be tightly coupled between sustainment and transportation allowing rapid assessment of transportation feasibility.

Program Goals

To achieve the vision of an advanced logistics system of the future, two categories of technology (Figure 7) must be developed: 1. planning, execution, and monitoring; and 2. infor-

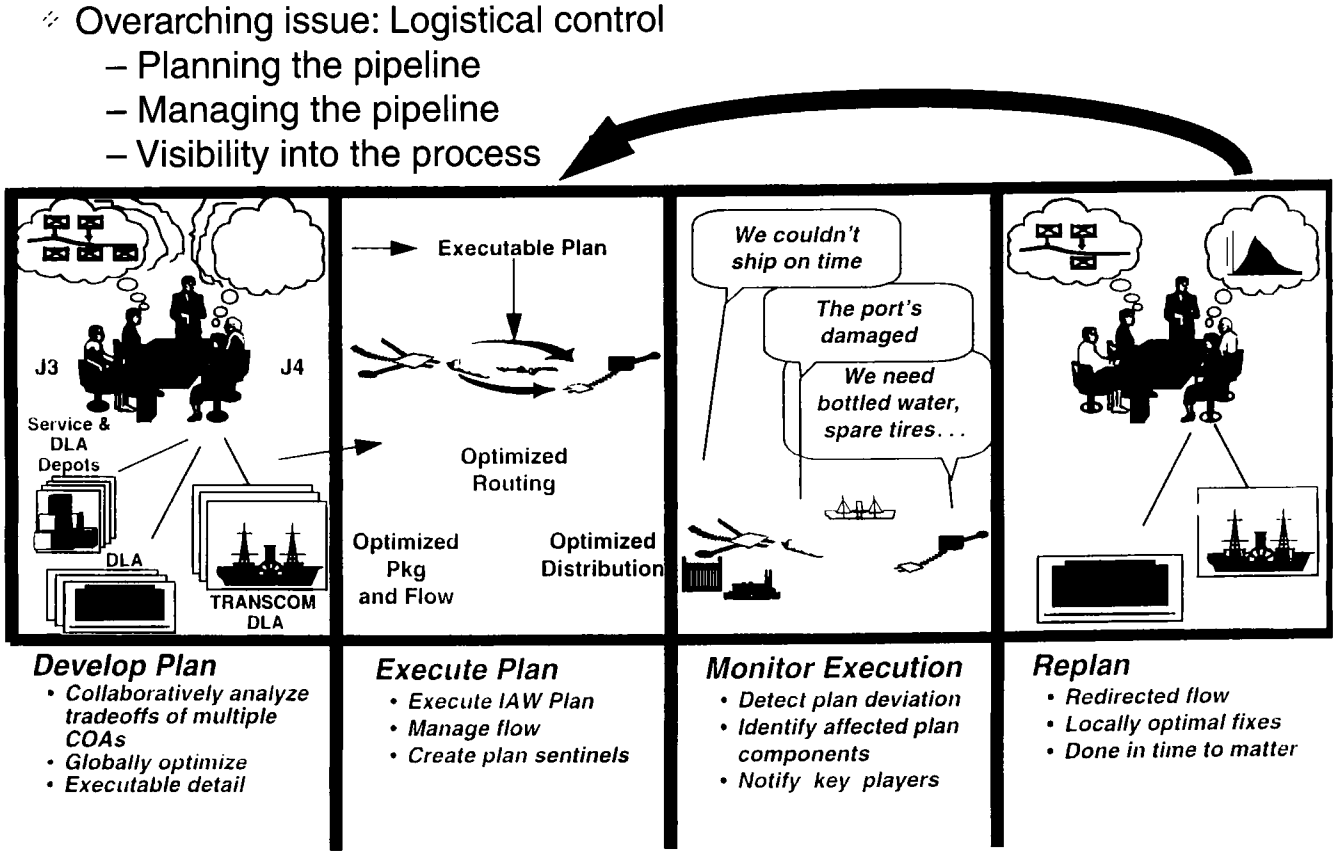

FIGURE 5 Envisioned is a more concurrent system process. Participants must work together to create a detailed plan. (*source: DARPA*)

mation assistants. These must be pursued within a system design and architectural framework that assures compatibility with non-DOD intermodal systems.

Controlling the logistics pipeline hinges on technologies developed for planning, execution, monitoring, and rapid replanning. These technologies will enable the logistics plan to be developed in consonance with the warfighting plan, the execution to be accomplished based on the details of the logistics plan, and responses to deviations made in time to matter.

Accurate and accessible information is the foundation on which the logistics systems must be built. We are developing technologies to support the autonomous connection of heterogeneous and distributed data bases, semiautonomous search and retrieval, and intelligent query for information. We envision that successful implementation will allow the operator to know where his stuff is and monitor its condition.

Concept of Operations

If there is to be success, the logistician must gain control of the logistics pipeline (Figure 8). Only by building on a foundation of advanced information technology can a fundamental change in how logistic planning and operations execution be achieved. Three components must interact to address this issue:

1. closed-loop planning to assure and implement tighter ties between operations and logistics,
2. faster acquisition to compensate for reduced inventory, and
3. intelligent use of lift to improve execution.

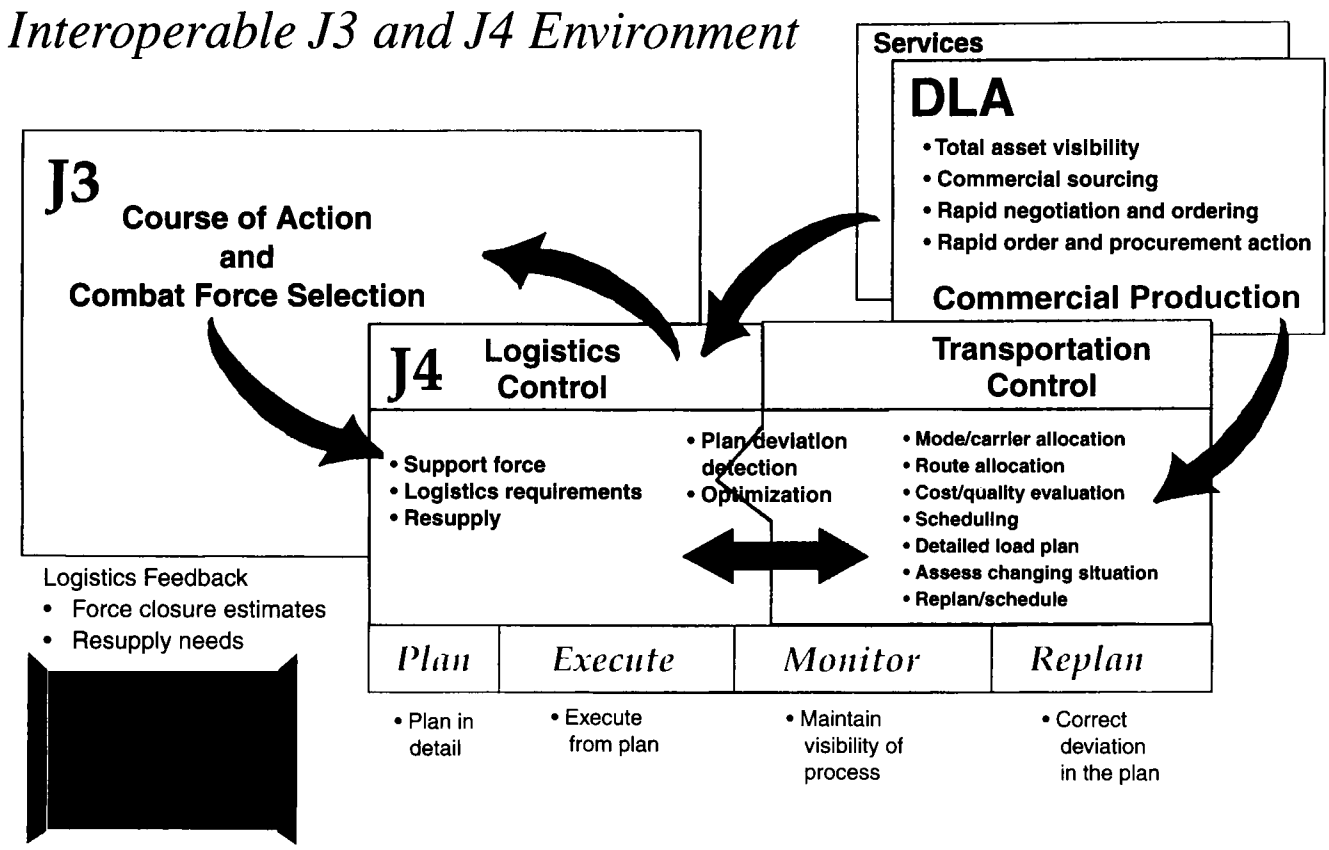

FIGURE 6 The solution is an interoperable environment in which both operators in J3 and logisticians in J4 coordinate their activities. (*source: DARPA*)

Technology must be developed that speeds logistics planning, execution monitoring, and replanning; ensures accurate, reliable, and timely information; and creates plan sentinels that ensure the accuracy of the information system and provide early warnings of events that deviate from the plan.

Oversight of the feasibility and cost of alternative courses of action is maintained throughout the cycle. It is supported by a closed-loop group of sustainment and transportation tools

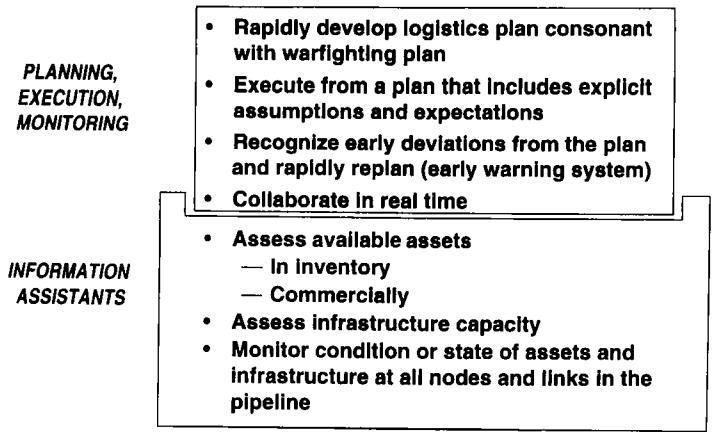

FIGURE 7 Program goals: planning, execution, and monitoring must be developed and information assistants must be trained to achieve the vision of an advanced logistics system. (*source: DARPA*)

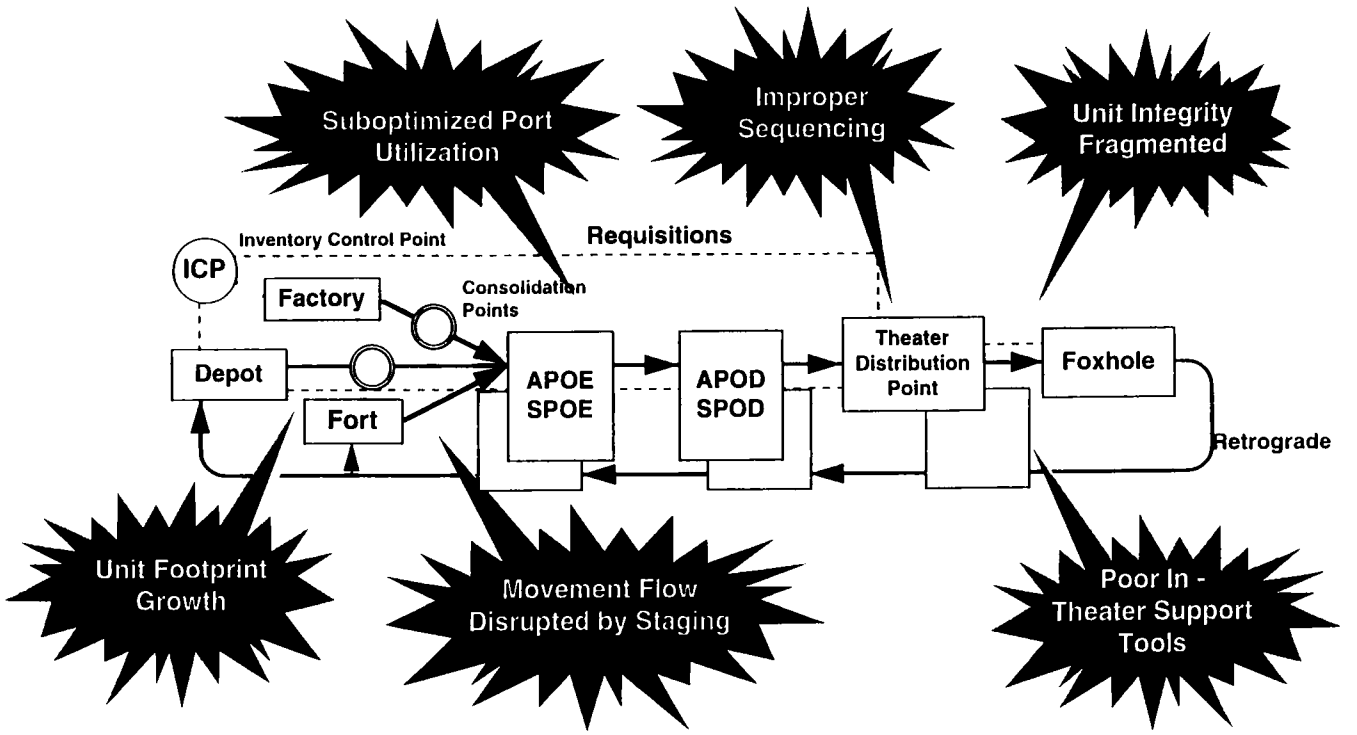

FIGURE 8 To achieve smarter use of lift, the logistician must gain control of the logistics pipeline. (*source: DARPA*)

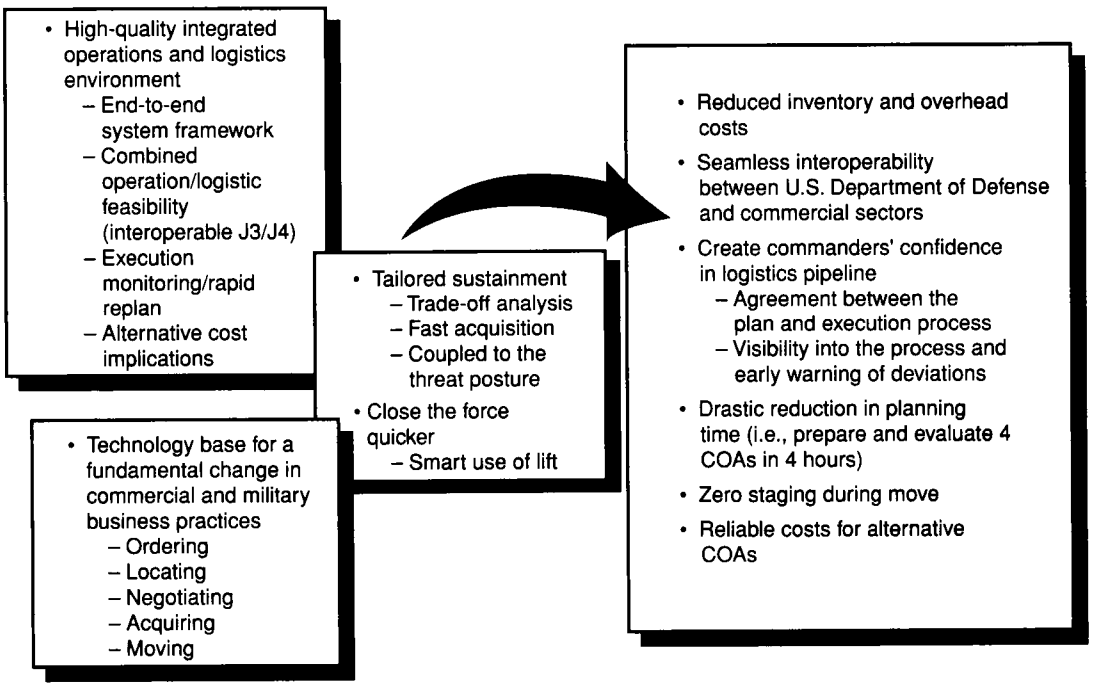

FIGURE 9 DARPA's Advanced Logistics Program will have direct and immediate impact on the warfighter and his logistics pipeline if we meet our goals. (*source: DARPA*)

that link with supply and procurement tools. The tools provide optimization, simulations, advanced data access services, and interface with commercial data services. The components together allow a complete end-to-end feasibility analysis.

Intended Impact of the DARPA Program

The DARPA Advanced Logistics Program will have direct and immediate impact on the warfighter and his logistics pipeline if we meet our goals (Figure 9). That means also a direct impact on the intermodal community. For the first time an operation will be planned with complete visibility into the logistics process. Planning time will be reduced from days to hours, there will be zero staging because all loading will be planned ahead of time, changes will be made while material is traveling en route, planners will have reliable cost estimates and be able to evaluate alternatives in real time, and operators will have seamless access to data and information without regard to query languages or data base structure.