

Defense Logistics

From DoD Stovepipes to “Focused Logistics”

Including a Post-September 11 Epilog¹

This working paper was written in late 2000 and released as part of a series in May 2001. After the terrorist attacks on September 11, 2001, an Epilog was added, beginning on page 26. The Executive Summary was also updated to include information from the Epilog.

■ Executive Summary

"Focused Logistics" is the capstone logistics concept of the Joint Chiefs of Staff. The goal is to exploit information technology, business process reengineering, and new transportation technologies to ensure delivery of the right materiel and forces at the right place at the right time. Four major trends will affect the realization of these goals and shape their impact on the nation's transportation system:

- Deployment timeframes are becoming more ambitious
- The importance of peacetime DoD transportation business is declining
- Defense and commercial supply chains are becoming more integrated
- Sensitivity to some safety and security issues is increasing

Despite DoD efforts to shrink the size or footprint of its deployment demand for freight transportation, the transition challenge from business-as-usual will become more difficult. The greatest challenge will be within the U.S., moving from Power Projection Platforms (forts) to and through ports and terminals.

¹ This working paper was prepared by Michael Wolfe of The North River Consulting Group, a member of the Battelle Team providing research and analysis support to the Federal Highway Administration Office of Freight Management and Operations.

The paper is one in a series of working papers providing initial analysis and discussion of the trends and issues affecting freight transportation productivity in the United States and North America. The series is available at <http://www.ops.fhwa.dot.gov/freight>. The working papers were prepared under contract DTFH61-97-C-00010, BAT-99-020. The opinions expressed in the working papers are those of the authors, not the Federal Highway Administration. The working papers are being circulated to generate discussion about emerging freight issues and may be updated in response to feedback from public and private sector stakeholders.

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Vulnerability to asymmetric threats, such as terrorism and sabotage, puts strategic mobility at risk. Although interdepartmental efforts address direct vulnerabilities, insufficient attention is paid to indirect vulnerabilities. The second order impacts of asymmetric threats could be more disruptive to civil and military cargoes than actual terrorist events.

Information technology is a two-edged sword: while adding robustness and efficiency, it simultaneously increases deployment risks and fragility.

The paper identifies three major issues that face DOT and the nation:

- Assuring that DoD has access to timely transportation capacity
- Mitigating potential disruption to civil commerce and defense production caused by Defense deployment surges
- Maintaining safety, improving security, and reducing vulnerability.

The Impacts of September 11²

Reviewing this theme paper three months after September 11, its conclusions appear fundamentally sound, although the emphasis must change in several ways.

The first and third trends remain intact--more ambitious deployment goals and tighter integration of defense and commercial systems and processes. The second trend, that declining volumes of peacetime defense shipments will probably stabilize on an absolute basis, seems reasonable. However, the trend could reverse due to an increased tempo of military operations, greater forward deployment of forces, or growth in the armed forces. The fourth trend, "sensitivity to some safety and security issues is increasing," stands out in stark relief.

Continuing acceleration of deployment timeframes for substantial fighting forces still seems likely to create greater transition challenges from business-as-usual. However, movement of special operations forces to the Aghan Theater illustrates that rapid deployment of relatively small light forces can be managed with little impact on the economy by organic USTRANSCOM capabilities and relatively modest commercial transportation resources.

Vulnerability to asymmetric threats is now seen as a risk to much more than strategic mobility. The first concern garnering more attention within defense logistics is direct terrorist threats to US armed forces and installations. The second concern is the potential to turn military materiel and transport into instruments of terror directed at civilians and civil infrastructure. There has been a watershed change, increasing the sense of urgency and devotion of resources to what DoD calls Force Protection.

² The review and update of this paper was consistent with the approach taken to the paper itself and described in the next footnote. The author reviewed materials, articles, and web sites and talked with key sources.

Force Protection is evident at the gate of every defense installation, where access and inspection controls have increased by an order of magnitude--including for commercial freight deliveries and pickups. In terms of freight transportation, the USTRANSCOM tightened controls significantly, especially for hazardous materials and munitions. Armed military escorts, for example, now accompany most munition shipments.

The three issues identified in the paper remain valid, although all are informed and nuanced by the chain of events that began on September 11.

■ Introduction

Defense freight transportation issues are important to DOT in at least four ways.³ First, an effective transportation system is essential to support national security and military deployments. Second, defense deployments have the potential to disrupt the transportation system and the economy. Third, defense freight transportation has important business impacts on major transportation industry sectors. Finally, safety is a continuing concern because DoD ships large amounts of munitions.

Given the size of DoD, the history of the individual military services, and the cultural drive of military commanders to own and control resources necessary for their success, there is a strong tradition of separate logistics “stovepipes.” Separate supply chains exist for many commodities, programs, and commands. Examples include medical and munitions logistics; individual contractor support channels for separate weapons systems; and direct purchase and shipment programs. Stovepipes complicate coordination. They increase total costs, can lead to over-consumption of scarce transportation resources, and often frustrate the needs of combatant commanders.

Stovepipes reflect technology in addition to culture. The limits of mainframe and mini-computer information technology (IT) in the past meant that stovepipes, for all their problems, were often the best available solution. Advancing IT reduces, if not eliminates, the need for and the tolerance of stovepipes – in industry as well as by DoD. DoD is committed to modernizing its logistics systems, making it one of the top three acquisition priorities of the Under Secretary for Acquisition and Technology.⁴

“Focused Logistics,” the capstone logistics concept of the Joint Chiefs of Staff (JCS), implicitly demands the demolition of uncoordinated stovepipes. *Joint Vision 2010*, published in 1996, is the “operational template for the evolution of the Armed Forces of the

³The information and analysis in this paper are based on two major sources. The first, part of a scan of defense freight transportation issues in the spring of 2000, was a document review to prepare an annotated bibliography. The second source was a set of 30 interviews and discussions with officials and expert observers. The interviews, mostly by telephone, were relatively open-ended conversations in the spring (11 conversations), or focused discussions based on the draft issue scan and briefing slides in the fall of 2000 (19 conversations). The interviews were not for attribution in order to encourage candor.

⁴*21st Century Logistics: DoD Strategic Logistics Plan*, August 1999, p. i.

United States.” Focused Logistics is one of four primary tenets of the joint vision, along with Dominant Maneuver, Precision Engagement, and Full Dimensional Protection.

“Focused logistics will provide military capability by ensuring delivery of the right equipment, supplies, and personnel in the right quantities, to the right place, at the right time to support operational objectives. *It will result from revolutionary improvements in information systems, ... reengineered processes, and advances in transportation technologies.*”⁵ Focused Logistics has implications for DOT and freight transportation providers.

■ Trends

There are four major trends related to the movement from stovepipes to Focused Logistics. The first concerns strategic mobility. The second trend reflects the absolute and relative decline of peacetime defense freight business. The third trend concerns business processes – the inextricable linking of defense and commercial practices and systems. The fourth deals with safety and security.

Deployment Timeframes are Becoming More Ambitious

National military strategy posits significantly shorter timeframes to deploy major military forces and their initial set of supplies from their peacetime stations to theaters of operations anywhere on the globe. Today’s goal is a timeframe less than half what the nation achieved in Operation Desert Shield 10 years ago, and the goal for the next decade is for about the same order of magnitude improvement yet again.

Strategic mobility has three components. If *deployment* – described in the previous paragraph – is the “front end” of strategic mobility, *sustainment* is the central element: the ability to establish and maintain sufficient and timely flows of all commodities needed by the deployed forces to operate in the field. Fuel and munitions are the two largest commodities needed by forces in combat. *Redeployment*, which usually occurs as operations are scaled down, concerns either return to peacetime stations or relocation to another theater of operations. Deployment and sustainment are the most salient features of strategic mobility from the perspective of the total freight transportation system.

Three factors affect the strategic mobility requirement: the mass to move, the distances to cover, and the time schedule to meet. For all but the most modest scenarios, strategic mobility depends on both commercial and organic DoD-owned transportation assets.

During the past decade, U.S. national strategy shifted from forward presence to power projection. The post-Cold War drawdown saw overseas garrisons shrink and remaining forces concentrate in the continental U.S. (CONUS). Other things being equal, power

⁵*Joint Vision 2020*, pp. 24-25, (emphasis added). This update, published in 2000, extended the concepts toward more aggressive experimentation.

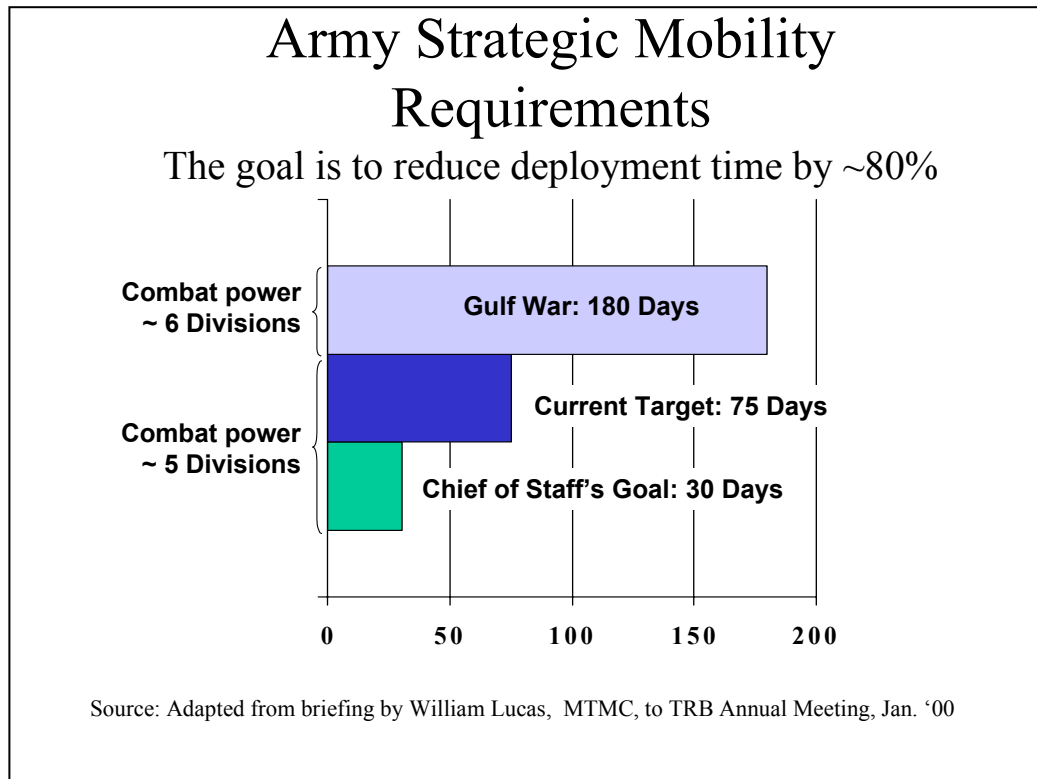
DoD’s emphasis on technology and timely, reliable service mirrors changes in the private sector. See related theme paper in this series, “Business Logistics: From Push to Pull Logistics.”

projection basing in CONUS increases the ton-mile movement requirement of global deployments.

The transportation implications of the national military strategy have been expressed in several *Mobility Requirements Studies*. *MRS 2005*, nearing completion, seems likely to reaffirm the requirement to support two nearly simultaneous Major Theater Wars (MTW). The most discussed scenario involves the Middle East and the Korean peninsula.

A major lesson of the Gulf War was that the U.S. and its allies cannot depend on adversaries to grant unlimited time for a buildup of forces. Because of this lesson, defense leaders are driving to shrink significantly the timeframe to marshal, move, and employ significant military forces from the continental United States to anywhere in the world. Figure 1 uses the U.S. Army as an example to illustrate this trend. In 1990, it took six months to deploy six divisions and supporting forces from the U.S. and Northern Europe to Saudi Arabia. The target today is to deliver nearly as much combat power in two and one-half months. The vision and goal of the Army Chief of Staff is, within the decade, to deliver equivalent combat power in one month. If Figure 1 were plotted as a curve with forces to deploy on the y-axis and time on the x-axis, each improvement would produce a steeper curve, concentrated further to the left on the chart.

Figure 1. Army Strategic Mobility Requirements



The Importance of Peacetime DoD Business is Declining

DoD is a less important customer to the freight transportation industry in 2000 than it was in 1990, and its importance will continue to shrink in relative terms, and perhaps in absolute terms as well.

Three factors combined to reduce the absolute and relative value of defense business over the past decade: the size of the armed forces shrank; forces deployed overseas shrank disproportionately because of the shift to power projection strategy; and commerce and world trade flourished. In the 1980s, for example, DoD was the largest single customer of the U.S. flag container carriers, providing about 14 percent of their export business. Today, although DoD is still the largest export customer, the percentage appears to be about five percent.⁶

Looking ahead, the absolute decline in DoD business is moderating, but the relative decline is likely to continue. Barring major national initiatives, military downsizing and the redeployment of overseas forces to CONUS is largely finished, so peacetime DoD business levels should be closer to level.⁷ However, as the economy and world trade grow, the proportion of DoD business will continue to shrink.

Although the foundation of this trend is quantitative, its importance is qualitative and subjective. The message is that profit-oriented commercial carriers are less inclined to make special allowances for DoD based on the importance of its day-to-day business.

Defense and Commercial Supply Chains are Becoming More Integrated

There are at least three aspects to this trend. Computer-to-computer links are growing quickly between defense supply and transportation systems and the systems of their industry trading partners. Second, supply chain business processes are becoming more integrated. Third, DoD is moving away from military-unique and toward commercial business processes for freight documentation, management, and payment.

The drive to improve efficiency is a major factor. The underlying revolution in information and telecommunications technologies affects all supply chain processes. Important organizing goals of the IT revolution – quality, customer service, responsiveness, and profitability – usually translate into greater efficiency. Greater and more effective supply chain integration is a major route to improved efficiency.

DoD logisticians are tying more supply chains together with industry partners. The simplest steps involve more automated exchange of data generated by operational transactions. Internet-based links will surpass older approaches, such as Electronic Data

⁶The five percent figure is anecdotal, provided by an interviewee with excellent maritime industry contacts.

⁷A retired Commander-in-Chief of USTRANSCOM wrote in private correspondence that defense freight volumes continue to drop. For example, the Air Mobility Command flying programs are 15% below budget because demand is lower than expected.

Interchange (EDI). U.S. Transportation Command's (USTRANSCOM) Global Transportation Network (GTN) is an important example of this trend, building data links with commercial carriers.

More profound integration mixes commercial and defense operations. For example, in the growing Direct Vendor Delivery (DVD) and Prime Vendor (PV) initiatives, commercial suppliers of items such as medical equipment, subsistence, and repair parts ship directly to end users in the armed forces. DVD and PV shipments generally bypass military depots and PV shipments bypass the Defense Transportation System (DTS). The Logistics Management Institute (LMI), in a recent study described by an interviewee, estimated that DVD shipments grew quickly to \$310 million, about 10 percent of the annual defense freight transportation bill.⁸ Based on discussions with inventory managers, LMI expects the portion to double by 2005. Another interviewee, a senior executive in the Army, disagrees; he expects the trend for the less-controlled DVD program to slow and be brought back "in house." This appears to be a minority viewpoint, and the economic incentives of DVD will be difficult to redirect.

A second example of mixed operations is the rapid growth of Contract Logistics Services (CLS). CLS programs vary widely, but the core is contracting out the maintenance and sometimes the parts supply for individual weapons systems. Some of the contracts are performance-based, with the contractor guaranteeing availability rates. CLS support is delivered overseas as well as in the CONUS. Although contractors are rarely expected to be in harms way, they will be part of large and small deployments.

Because program managers regard CLS as flexible, responsive, and economical, the programs are growing more common. The LMI study mentioned about 45 weapon systems, scattered across the military services, whose managers were actively considering CLS options. Fifteen of those systems, most in the Air Force and the Army, were already under CLS.

Looking ahead, one cutting edge in industry is processes that combine operational data, simulations, and forecasting models. These tools and processes, such as Collaborative Planning and Forecasting for Replenishment (CPFR) and Collaborative Transportation Management (CTM), are designed to better harmonize production, shipment, and inventory levels throughout complex supply chains. It seems reasonable to forecast that DoD logisticians will experiment with and come to use these advanced forms of integration with selected suppliers.

Reflecting the tenet of Focused Logistics, supply chain integration is taking place within DoD as well as between DoD elements and industrial suppliers. The Strategic Distribution Management Initiative (SDMI), a joint program of USTRANSCOM and the Defense Logistics Agency (DLA), illustrates the trend. Using a define-measure-improve-iterate process, SDMI innovations include synchronizing the operations among a DLA consolidation depot, trucking companies, and USAF-managed airlift to shrink Order-Ship-Time (OST) and Customer Wait Time. One target, according to a senior level interviewee,

⁸ The focus is on expenditures for commercial freight transportation services, excluding shipments of household goods.

is to reduce OST for requisitions from Bosnia shipped via airfreight from an average of 15 days to eight-to-10 days.

SDMI is also useful to illustrate another facet of the integration trend: the growing adoption of commercial supply chain practices. According to several interviewees, SDMI grew out of the conviction that the current DoD supply chain, both in the U.S. and overseas, is an uncoordinated mix of inventory locations and distribution modes – another way of saying that DoD’s supply chain contains many stovepipes. An unofficial copy of a major presentation to USTRANSCOM’s Deputy Commander-in-Chief illustrates the attraction of commercial practice. The text asserts, “No competent business would tolerate such a situation! ... Modern business practices emphasize scheduled and synchronized flows to reduce wait time and enhance predictability. Minimization of inventory levels and locations based on planned distribution patterns [should be the goal] (a la Wal-Mart model).”

Accelerants of the Trend. DoD budget pressures are a catalytic push for the trends to greater integration and adoption of commercial practices. “Warfighters” look to support elements, including logisticians, to be billpayers for weapons modernization by working smarter and leaner. “Smarter and leaner” often means “more like industry.”

Increased DoD exposure to the industry best practices is a catalytic pull toward greater integration and adoption of commercial practices. For example, even in the late 1980s, it was rare for government logisticians to attend the Council of Logistics Management (CLM), the premier professional group for advancing the practice of business logistics. Now DoD personnel and support contractors are common at CLM meetings. Greater awareness reinforces the trend toward adoption of best commercial practices.

Sensitivity to Some Safety and Security Issues is Increasing

The trend line in sensitivity to safety and security related to defense freight transportation varies by segment from an already high plateau, to significant increase, to very low attention. In the first segment, the integrity of munitions and other sensitive shipments, awareness reached high levels some time ago and the trend line is flat. In the second segment, direct vulnerability to disruption, sensitivity is increasing. The third segment, indirect vulnerability to disruption, hardly appears on any radar screen.

Integrity of Sensitive Defense Shipments. Sensitive shipments include munitions, weapons, classified materiel, and unusually high-value cargoes. The absolute level of safety and physical security is remarkably high. The best performance indicator, ironically, may be the absence of performance indicators. In 1999, a major study of the munitions safety and security found only individual incident reports, not statistics or trend data. That study reported that, “Munitions transportation operations are conducted with few accidents or incidents.”⁹ “Physical security of DoD shipments of munitions, classified material, and sensitive (high-value, pilferable) items appears to be quite good – we have no quantitative information demonstrating the existence of a severe or growing problem

⁹ *Study to Improve Efficiency, Safety, and Security for Loading and Transporting Military Containerized Munitions*, Final Study Report to the Military Traffic Management Command, DAMT01-98-C-2001, 9 November 1999, Harvey Consultants, Inc., et. al., p. xi.

in this set of commodities. To our knowledge, no munitions shipments have been stolen.”¹⁰

Sensitivity to the safety issues leaped in the mid-1980s after highly publicized incidents such as the spillage of torpedoes on I-25 in Denver. In 1990, first the Navy and then DoD as a whole required munitions motor carriers to adopt then-new satellite monitoring technology to improve visibility and response times for safety and security.

Given the generally excellent performance of the DoD and its carriers, there have been no major shifts in safety sensitivity, procedures, or apparent results. All have been on a high plateau for the last decade.

Sensitivity to physical security has continued to increase due to two factors. “The first ... is increasing terrorism, foreign and domestic, which heightens concern about protecting explosives, weapons, and devices that are particularly attractive to terrorist groups. The second ... is increasing theft [in the freight transportation system].”¹¹

Direct Vulnerability to Disruption. There is a perceived – and probably real – trend of increasing security risks to the freight transportation system, and this is a growing concern for defense freight transportation.

The security community often refers to “asymmetric threats,” including terrorism and sabotage.¹² The direct threats of most concern, beyond weapons of mass destruction aimed at civil or military targets, are aimed at critical infrastructure, including transportation. For example, *The Clinton Administration’s Policy on Critical Infrastructure Protection: Presidential Decision Directive 63* estimated in 1998 that the country had a three-to five-year window within which to prepare for increased threats to physical and information infrastructures.¹³

The perception of growing threat occurs in a context of declining numbers of attacks. According to the Interagency Commission on Crime and Security in Seaports, “Both within the United States and worldwide, the numbers of terrorist attacks are decreasing, but the numbers of casualties and the levels of property damage are on the rise.”¹⁴

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Ibid., p. 147.

¹¹ *Ibid.*, p. 147. Although theft of munitions is not a problem, and no interviewees commented on DoD’s cargo theft experience, theft is a growing problem in commercial freight transportation. For example, an FBI report asserted that, “The theft of Cargo has become so widespread that it constitutes a serious threat to the flow of commerce in the United States.” Quoted in “Technical Memorandum 21, Freight Transportation Security Problems,” Reebie Associates for the FHWA Multimodal Freight Analysis Framework, Task 4, Freight Issues Scan, undated, p. 1.

¹² For example, Joseph Cyrulik lists seven types of asymmetric attacks in *Asymmetric Warfare and the Threat to the American Homeland*, AUSA Landpower Essay Series No. 99-8, November 1999, pp. 4-6.

¹³ The White House White Paper is dated May 22, 1998. The paper is on the Internet at <http://www.fas.org/irp/offdocs/paper598.htm>.

¹⁴ *Report Of The Interagency Commission On Crime And Security In U.S. Seaports*, Fall 2000, p. 59.

Indirect Vulnerability to Disruption. Asymmetric threats seem to present growing potential indirect or second order risks to defense freight transportation in general and to strategic mobility in particular. Indirect risks could include significant increases in congestion and confusion that interfere with either critical defense production or transportation operations.

One example would be the use of a commercial intermodal container to smuggle a weapon of mass destruction, such as chemical or biological agents, into a large city. The resulting security scare could require detailed manual inspections of all import containers, effectively throttling commerce.¹⁵ Strategic mobility would be affected adversely both by significant port congestion and by disruption of contractors' supply chains.

There appears to be no trend indicators for secondary threats. However, if the threat of asymmetric attacks against the U.S. is indeed increasing, then the risk of second order effects is probably increasing too. Given that little attention appears to be paid to the indirect effects, it is equally likely that vulnerability to these effects is increasing even faster.

■ Implications

The Deployment Challenge is Becoming More Difficult

In the best of circumstances, the trends imply that the strategic mobility challenge will increase for major deployments. DoD's significant and productive strategic mobility actions, discussed below, will merely ameliorate a growing problem. It may be that the aggressive force closure goals, shrinking from an actual six months in the Gulf War to two-and-one-half months today, and then to one month, will outweigh all mitigation strategies.

Two factors explain this implication, *timeliness* and *transition*. The aggregate lift requirement is less important because, given sufficient time, a resilient transportation system and a resilient economy will accommodate new patterns of demand.

All else being equal, a more ambitious timeframe for deployment concentrates demand, requiring higher levels of performance to provide timely service. More important, a narrower timeframe steepens the slope of the demand curve, sharpens the angle of the initial inflection point, and reflects a more challenging transition from peacetime to power projection. Since the heart of transition is separating transportation assets from tightly coupled commercial supply chains, more ambitious time goals imply increased potential for both commercial disruption and frustration for military plans.

¹⁵ A similar scenario was discussed during a 1997 port readiness exercise, attended by the author, at Howland Hook terminal in New Jersey.

A Shorter Demand Spike can be More Difficult if it is Steeper

Figure 2(a) is a useful template to illustrate this implication. The chart summarizes an assessment at USTRANSCOM that asked, in effect, “what could have been accomplished to deploy for the Gulf War if the best technologies had been in use prior to the deployment?” The area under the right-hand triangular curve represents the actual mass of materiel transported to and from the theater, with the peak volume on the ground appearing to occur on day 215, after the end of the ground war. Given superb logistics visibility, movement planning, and synchronization systems, the analysts estimated that the war could have been fought 100 days sooner with one million fewer tons of materiel.

Figure 2(a). Impact of Information Systems Technology on Force Deployment

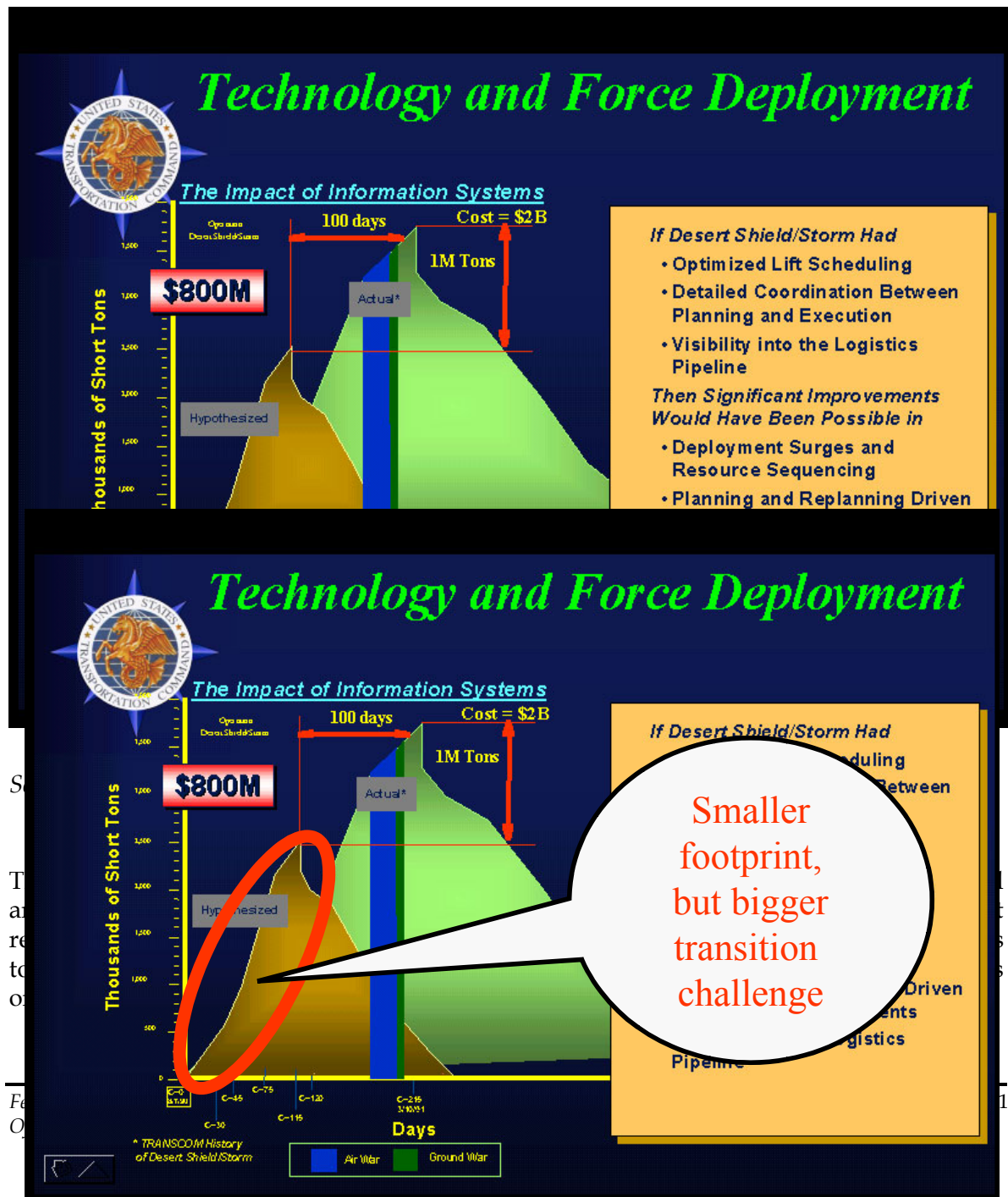


Figure 2(b). Faster Transition Vs. Smaller Footprint

The hypothesized curve in Figure 2 can be thought of as a rough surrogate for today's deployment goals, such as the Army's target of five divisions worth of combat power on the ground in 75 days. The future goal of delivering the same combat power in 30 days implies a third hypothesized curve with less total mass, more compression to the left, and a sharper vertical spike.

DoD's is procuring significant organic transportation resources to address that sharper vertical spike demand. Those land, air, and sea transportation resources will help, but they will not absorb the entire burden. DoD will need significant commercial transportation support, and they will need access to it even more quickly.

The stress of transition has two facets: pressing to garner sufficient resources to meet national security requirements; and trying to manage the disruptive effects on the economy. The ambitious timeframes of emerging national strategy promise to increase the stress on both facets.

Some Transportation Implications of a Major Military Deployment

Civil transportation professionals understand, in general, that military operations imply significant transportation burdens. The next several paragraphs provide concrete illustrations of that burden. The brigade and division examples focus on unit *deployment*, not the requirement to move *sustainment* supplies.

One Light Brigade. As discussed earlier, the Army's goals are to deploy combat power of up to five divisions anywhere in the world in 75 days in the near term and in 30 days in the longer term. In both cases, the first brigade – roughly one-third of one “light” division, probably the 82nd Airborne – is to be in place within 96 hours. The initial brigade alone, interviews stated, would require 60 percent of all U.S. Air Force strategic lift capability for three days.

One Mechanized Division. The maneuver brigades of a mechanized division are roughly two-thirds armored infantry and one-third tanks. A mechanized division today is about 17,000 people; 1,686,000 square feet of materiel; and 8,160 vehicles, of which 3,700 are self-propelled, 2,300 are trailers, and 1,700 are tracked.¹⁶

Moving this division from fort to port would require 1,722 89-foot flatcars; 534 60-foot flatcars; 214 heavy-duty flatcars; and 524 20-foot containers. The ocean movement would require 9.6 Fast Support Ship voyages or 5.9 Large Medium Speed Roll-On/Roll-Off (LMSR) ship voyages.¹⁷

¹⁶ An interviewee provided the mechanized division information over the telephone, using the 1997 edition of MTMC Transportation Engineering Agency's *Deployment Planning Guide*.

¹⁷ The FSS are the rebuilt Sea-Land SL 7s, and the LMSRs are DoD-funded new construction.

Operation Desert Shield/Desert Storm. This was a single MTW. Deployment plus sustaining supplies required 500 shiploads and 9,000 aircraft loads. Among the cargoes were 12,400 tracked vehicles and 114,000 wheeled vehicles of all sizes.¹⁸ Roughly, 500,000 U.S. personnel were moved to the theater.

One MTW Impact on Airlift. An interviewee in the USTRANSCOM aviation community reported that a single MTW scenario would require roughly 50-55 percent of the U.S. long-range international (LRI) cargo fleet. This would be in addition to the most of the effective inter-theater capacity of the USAF Air Mobility Command.

Current National Strategy. As noted earlier, current strategy calls for supporting two nearly simultaneous Major Theater Wars. All indications from the interviewees were that the *Mobility Requirements Study, 2005* will endorse this strategy. The *MRS 05* scenarios probably envision less than twice as much mass to be moved compared to the requirement of the Gulf War, but the notional *MRS 05* scenario would be more complex, since it probably envisions redeploying combat units from MTW I to MTW II.

DoD Efforts to Ease the Deployment Burden

In 1995, the Chairman of Joint Chiefs of Staff said “If we do not build a transportation system that can meet our needs tomorrow then it doesn’t matter what kind of force we have because we won’t be able to get it there.” This section describes six DoD initiatives that are designed to improve the strategic mobility situation.

Prepositioned Equipment and Materiel. The Army and the Marines, which generate major portions of the strategic mobility burden, have loaded ships with unit sets of equipment and supplies. The Army has equipment for one of its five target divisions stowed in this manner. The ships are stationed overseas, in locations such as Diego Garcia in the Indian Ocean, ready to sail on short notice to deployment sites, for example, in the Middle East or East Asia. Units of soldiers or Marines would be flown in to marry with the sets of equipment.

The “prepo afloat” programs have two major advantages: first, they avoid the movement to and through ports in the CONUS, saving time and minimizing congestion. Second, they may reduce steaming time to the designated theater, permitting earlier deployment.

New Strategic Lift Equipment. DoD-owned assets under USTRANSCOM’s control are the core quick response capability. The USAF C-17 program is a major investment in long-range international airlift, capable of carrying outsized equipment and landing at less than ideal airports. Sixty-nine of 134 programmed C-17s have been delivered. Even a skeptical interviewee agreed that the C-17s, together with Civil Reserve Air Fleet (CRAF) Stage II augmentation (similar to the Gulf War), could support a single MTW scenario.

¹⁸ Taken from an undated briefing prepared by the Army’s Combined Arms Support Command and the Transportation Center at St. Eustis, VA. The figures appear to cover all Services, not just the Army.

The Navy's program of 20 LMSRs, 13 of which have been delivered, is another major strategic mobility investment. The Navy also invested in several crane ships, designed to work non-self-sustaining containerships in undeveloped or non-existent ports.

The Army, with smaller investments, added several thousand leased containers to its fleets of Army-owned containers. These containers are prepositioned at troop installations and some plants and depots. The Army is also purchasing 349 COFC railcars for containerized munitions, sufficient to handle about two days of supply in a crisis.¹⁹

Revitalizing Essential Civil Sector Support. DoD transportation leaders are aware of the declining peacetime business they provide to commercial carriers and their dependence on those carriers. There are several initiatives to assure timely and economical access to transportation service. The principal venues, however, are CRAF and VISA.

The Voluntary Intermodal Sealift Agreement (VISA) was established with the ocean carriers in the mid-1990s. VISA addresses availability of containerships. CRAF is the focus of two efforts. The Select Working Group, which includes industry executives, is focusing on short-term improvements. USTRANSCOM also contracted for a longer-term assessment of CRAF, and the study should be delivered by July 2001.

Exploiting Information Technology. This is a major element of Focused Logistics, with at least two major thrusts. The first is making operations more transparent. Examples include Total Asset Visibility, Intransit Visibility, and greater use of Automated Identification Technologies. The second thrust is greater use of advanced modeling, simulation, decision-support, and visualization tools. The goals are to improve the quality and timeliness of actionable information, leading to more optimal logistics operations.

Lightening the Footprint. If combat forces can succeed and survive with lighter and less materiel, then the forces will be easier to project and sustain. One interviewee, an astute observer of strategic mobility issues, believes that the Army and the Marine Corps are serious about reducing the weight of unit equipment. "There is a clear understanding that the status quo will not work." The Army's goal is to develop a main battle platform comparable in lethality and protection to today's 70-ton Abrams tank, but weighing only 20 percent as much. Further, all of the new equipment is being designed to fit the cabin templates of the intra-theater C-130 and the Boeing 747-400F.

Developing and fielding new combat vehicles is not a speedy enterprise. An interim brigade, using wheeled battle platform(s) is to be ready by 2003. However, the target for the first division to be equipped with the new generation battle platform is 2012.

Lightening the logistics footprint extends beyond unit equipment. Munitions and fuel are the largest volume consumables in an active theater of operations. The armed forces are pursuing precision munitions because, in addition to improving combat effectiveness,

¹⁹ The 349 COFC cars were mentioned by Alan Estevez, Deputy, Assistant Deputy Under Secretary of Defense (Logistics)/Transportation Policy, at the January 2000 TRB panel on "Shrinking Excess Capacity in the U.S. Transportation System and its Impacts During a Military Crisis."

they can help lighten the footprint. When munitions provide reliable first round kills, logisticians can ship fewer rounds.

DoD and DOT interests converge in fuel efficiency. DoD is pursuing drastic improvements, even beyond the benefits of lighter combat vehicles. The director of an R&D center described the 21st Century Truck projects in the Army and the Department of Energy. Using fuel cells and hybrid technologies, they are forecasting three-fold improvements in both fuel efficiency and emissions.

Advanced Transportation R&D. Thoughtful leaders in the DoD, abetted by the Congress, DOT, industry, and academe, are investing resources to define, design, test, or launch advanced systems that would improve the deployment of forces. The top priorities of DoD transporters appear to be high-speed sealift and agile ports. There is also interest in 150-mph heavy lift cargo airships.

One focal point for these efforts is the Center for the Commercial Deployment of Transportation Technologies (CCDoTT), using earmarked federal funds in cooperation with USTRANSCOM and MarAd. CCDoTT reflects a strong preference in DoD for dual-use solutions in these new R&D programs. The goal is to minimize DoD investments and proliferate the widespread commercial adoption of militarily useful technologies.

Another R&D interest, which seems to receive less direct effort, is increasing traffic management capacities in air and land modes. However, several interviewees were skeptical that IT and ITS-like technologies could provide significant breakthroughs in infrastructure capacity.

DoD Perspectives on Modal Availability for Surges

The first leg in the deployment process is "from fort to port." DoD refers to the major origin forts as "Power Projection Platforms" and designates their corresponding ocean terminals as "Strategic Ports." Some of the interviewees and sources regard this leg of deployment as the most difficult, because it combines large amounts of heavy and outsized equipment with the earliest movement requirements.

Railroads. The Military Traffic Management Command (MTMC) is responsible for orchestrating the movement from forts to ports. The MTMC commander testified to the Surface Transportation Board that "our nation's military goes to war on rails."²⁰ Timely access to sufficient railroad capacity is a major concern. In a two MTW scenario, the DoD would require 2,840 flatcars in the first four days and 8,345 flatcars in the peak week.²¹ The totals include heavy-duty flat cars that can carry 70-ton main battle tanks and 89' and 60' chain tie-down flatcars, needed for lighter equipment. These cars are of shrinking commercial value, and the fleet has been aging and in long-term decline. The total inventory includes 741 DoD-owned and 6,626 carrier-owned flatcars, not all of which may be serviceable. MTMC and the AAR are completing a joint study of this challenging problem.

Intermodal capacity is also a railroad issue. Given the preponderance of containerization in international liner trades, DoD recognizes it must prepare to deploy forces using containers. In addition to non-trivial internal issues of training personnel to out-load in containers, there are intermodal capacity problems. The biggest challenge is timely access to intermodal railroad equipment, such as double-stack and flatcars, and to intermodal rail terminals. Containers do not appear to be a major problem for the deployment phase because DoD owns or leases a significant fleet of intermodal containers, most of it pre-positioned at important installations. Challenges may develop for the sustainment phase for some equipment, such as 20' containers, especially in a strong economy.

Timeliness is a challenge because the best commercial equipment is in use, hopefully under load, not marshaled close by major DoD unit bases. Railroads must locate needed equipment, possibly off-load it, then route it to military installations. That takes time.

Underlying rail equipment and terminal concerns is a broader infrastructure question. DoD requires connector lines, in good condition, to its major deployment installations. Rail mergers and line abandonments can undercut service and disrupt deployment plans.

To ensure adequate service, MTMC's Transportation Engineering Agency (TEA) manages the Railroads for National Defense program and publishes the Strategic Rail Corridor Network (STRACNET) report.²²

Motor Carriers. Despite DoD's heavy reliance on railroads for unit deployment, there is also an important role for motor carriers. The first challenge is heavy equipment tractor-trailers, capable of hauling tanks and other tracked equipment. Since much of this equipment supports the construction industries, not transportation common carriage, visibility and access are more difficult. MTMC and TEA try to monitor this fleet.

The second highway challenge is for munitions carriers. This specialized business requires excellent equipment and specially trained drivers; general highway van trailers

²⁰ March 7, 2000, quoted in "MTMC Commander: 'Proposed Canadian-U.S. railroad merger needs careful review,'" *TRANSLOG*, May 2000, p. 20.

²¹ Pre-completion results of an AAR-MTMC flatcar study, using MRS-05 data, presented by William Lucas to the TRB Annual Meeting, January 9, 2001, "Fort to Port Surface Deployments—The Next Decade."

²² See "Preserving Strategic Rail Mobility," *Army Logistician*, Nov-Dec 1999, Robert S. Korpanty.

and drivers are not immediately transferable to the munitions business. DoD is a much bigger customer for the munitions carriers than it is for other motor carriers. Consequently, the downsizing of DoD has had a disproportionate impact on the munitions carriers, which tailored their capacity to the current demand. The remaining fleets are less able to accommodate a major deployment surge. One response has been movement toward a Munitions Carrier Readiness Program to enhance the industry's ability to respond.

Port Staging Capacity. Aggressive deployment timelines and masses of equipment and materiel that will move by ocean form a significant challenge in sequencing flows to and through ocean ports. The challenge is greater because ships must be loaded to preserve unit integrity and meet military requirements on the far shore. The planning and coordination burden is greater too because DoD is using fewer, larger ships.

The port staging challenge is compounded because the major military ocean terminals on the east and west coasts closed as part of DoD's downsizing. Another complicating factor is the dominance of intermodal operations, which reduces the proportion of available commercial port staging space for breakbulk and RO/RO cargoes.

Our interviewees are concerned about the timely availability of staging capacity in and near ocean terminals, particularly if commercial terminals are actively engaged with private cargoes at the start of a deployment. The interviewees are also concerned about the DoD's ability to orchestrate the flow of unit and materiel movements to the ports. For example, senior officials in the Navy and Army agreed that it would be easier to get sufficient ships to loading ports for a major deployment than it would be to sequence and marshal the Army forces for optimal ship loading. (That conclusion reflects, in part, the rail and highway difficulties addressed above).

Air Freight. USTRANSCOM and others in DoD seem to think that the combination of USAF organic aircraft and commercial aviation can support most deployments.

A concern at USTRANSCOM, as expressed in research for this paper, is more on handling outsize cargo than on sheer volume. Since the holds of commercial freighters cannot accommodate the same dimensions as large military aircraft, some interviewees see commercial air cargo as best suited for sustainment supplies, not unit equipment.

Even if CRAF were not activated, its constituent aircraft and crews would be the main source of commercial aviation support for a deployment. The most important segment of CRAF is the Long-Range International (LRI) fleet, about 532 passenger and cargo aircraft in January 2000.

The cautious optimism about airlift capacity seems concentrated on supporting a single MTW; some interviewees were careful to make this qualification. If, as indicated in an earlier section, a single MTW requires roughly 50-55 percent of the entire U.S. civil long-range international cargo fleet plus most of the USAF international fleet, it seems reasonable to question the capacity to support deployments to two nearly simultaneous MTW.

Ocean Shipping. A senior official in the Navy, in discussing this paper, said that the vessels currently available to DoD and MarAd can support current *deployment* plans. These

vessels, available on five days notice, include eight Fast Sealift Ships, 13 LMSRs, and other five-day ships of the Ready Reserve Fleet (RRF).

A senior civilian in the Army logistics community agreed with the Navy view, although he questions the utility of the RRF vessels because they are too slow to load and unload. The Army prefers to depend on the FSS and LMSR RO/ROs.

If the interviewees are correct, available capacity for sealift is more of an issue for *sustainment* shipments than for initial deployment. However, the availability of organic sealift eases, but does not eliminate, the challenge of transition to deployment.

Impact of Growing Demand and Congestion. Forecasts prepared as part of the FHWA's Multi-Modal Freight Analysis Framework Project estimated the physical volume of freight movements in 2020.²³ Regional growth rates over 20 years vary from 79 percent in the Northeast Region to 100 percent in the West Region.

The forecasts imply significant challenges for infrastructure capacity, condition, and congestion. The challenges relate to each area addressed above: rail and rail terminals; highways and connecting roads; port marshalling and throughput; airfreight adequacy and terminal capacity; and sealift. More crowded highways, for example, can impede military convoys; and a surge in military convoys can disrupt already congested roadways.

If economic growth is close to the WEFA forecasts, DoD may find that future modal availability for surges is more of a challenge.

More Integration Will Increase Efficiency, Effectiveness, and Collaboration

Integration of military and civil freight transportation and logistics systems affects the productivity and effectiveness of defense freight operations in peace and war. Although there are some counterproductive impacts on force deployment, which will be addressed later, most implications of the trend toward supply chain integration are positive.

DoD has become more flexible and experimental, which implies that business practices and relationships with suppliers are likely to keep changing and improving. For example, there has been great progress in shifting from DoD-unique freight documentation – Governments Bills of Lading – to commercial documentation. Freight payment practices have been streamlined and carrier cash flow improved with third-party payment processes. There are also 3PL experiments in freight shipments.

²³ The estimates combined 1998 freight data prepared by Reebie Associates with 2020 economic forecasts by WEFA. The results were reported to the TRB Annual Meeting in January 2001 and are available on the web site of FHWA's Office of Freight Management and Operations (<http://www.ops.fhwa.dot.gov/freight/adfrmwrk/index.htm>).

As in industry, DoD inventory reductions reflect efficiency improvements from better supply chain management. Recently a senior official reported DoD's success in reducing inventories from \$67 to \$52 billion while cutting logistics response times in half.²⁴

Effectiveness, quality, and customer service are likely to keep improving. DoD adopted Customer Wait Time (CWT) as an overarching metric and, since improvements tend to follow measurement, the CWT metric seems likely to yield continuing improvements in pipeline velocity and reduced variability.

As DoD becomes more integrated with and attuned to commercial practices, it is likely to become an even more energetic policy collaborator with DOT and a helpful partner in a national freight productivity program. Two illustrations are that DoD and its carrier partners are likely to become more vocal about addressing congestion; and DoD is likely to become more active in pursuing effective supply chain standards.

Sensitivity to HAZMAT Safety and Security is Subject to Sudden Change

The safety and physical security of sensitive defense shipments are critical for three reasons: meeting mission requirements, protecting the public, and keeping the public's confidence in the freight transportation system and the public sector leadership. Public confidence can change rapidly in response to highly publicized incidents, with significant impact on policies and procedures.

The reaction to the Denver torpedo incident, discussed earlier, illustrated the latent public and official intolerance for major breakdowns in defense freight transportation safety, especially concerning munitions. The response to that incident was constructive, but focused on highway shipments.

DoD "micro-manages" sensitive highway shipments.²⁵ All approved munitions motor carriers must use a system comparable to Qualcomm's OmniTRACS satellite monitoring service, augmented with an emergency call "911" button. The carriers grant DoD commercially unprecedented direct access to real-time data on sensitive DoD shipments.

The concentration on highway shipments seems linked to two factors: public pressure from the mid-1980s incidents and the timely availability of a cost-effective monitoring service. No other mode has had the combination of incidents and feasible tracking alternatives – factors that are subject to change over time.

The focus on highway shipment safety yields collateral benefits for physical security through closer monitoring. As noted in the trend discussion, DoD's security experience for sensitive shipments is excellent in all modes. Of course, one or more publicized thefts, especially connected with a terrorist incident, could cause a strong public reaction.

²⁴ "From Factory to Foxhole," *Inbound Logistics*, October 2000, Leslie Hansen Harps, p. 55, quoted the Under Secretary for Acquisition, Technology, and Logistics.

²⁵ "Micro-manages" is not pejorative. Some defense munitions transportation personnel speak proudly of their ability to micro-manage munitions movements via motor carriers.

Given DoD's special concern about munitions, weapons, and classified shipments, plus the growing concern about terrorism, one can draw several conclusions. One should expect that defense freight transportation and security managers will collaborate with commercial shippers and carriers to mitigate theft problems and improve safety. Further, given DoD's positive experience with satellite monitoring of highway munitions movements, DoD is likely to encourage freight shippers and carriers to adopt promising new monitoring technologies. Finally, it is possible that an incident could precipitate sudden action to improve protection.

Vulnerability to Asymmetric Threats Undercuts Strategic Mobility

Risks such as terrorism and sabotage directed at the freight transportation system could seriously aggravate the difficulties of strategic deployment and sustainment. The direct and indirect risks also extend to general freight transportation.

Direct Vulnerabilities. Terrorism is an exogenous factor that could suddenly and seriously disrupt both general and defense freight transportation capabilities. Specific risks include targeting transportation system physical infrastructure, supporting infrastructures (information, communications, and power), or transportation operations.

DoD, on its own and in cooperation with other agencies, works to understand and mitigate these risks. For example, the Critical Infrastructure Protection (CIP) Team at the MTMC's TEA performs "Transportation Infrastructure Criticality And Vulnerability (TRI-CAV) assessments for all of the major Power Projection [bases], ammunition depots, and 'other' key sites of interest to DOD. TRI-CAV will produce a summary of the nation's transportation infrastructure and assets along with recommendations for remediation, mitigation, and consequence management activities where warranted."²⁶

Indirect Vulnerabilities. Indirect or secondary impacts could be more disruptive to civil and military cargoes than actual terrorist events. As in one of the examples given earlier, political leaders could react to a terrorist incident delivered via intermodal container by disrupting the processing of all containers.

Very little is written or discussed in the public domain about potential indirect effects. The Interagency Commission on Seaports reports that "consequence management" is one of three fundamental activities of combating terrorism. "Consequence management involves the aftermath of an attack. ... the Federal Emergency and Management Agency will lead the consequence management phase, utilizing the Federal Response Plan."²⁷ The Federal Response Plan may not fully ascertain how it addresses disruptions to freight flow. Few of the interviewees commented on indirect effects, although senior officials in the Army and the research community did endorse the hypothesis about simultaneous increases in robustness and fragility, which is discussed in the next section.

Crosscutting Implications. The safety, security, and vulnerability risks imply that there may be significant value in aggressive R&D and deployment of remote monitoring and

²⁶ Taken from the TEA web site, <http://www.tea.army.mil/sa/ci.htm>.

²⁷ *Report Of The Interagency Commission...*, p. 60.

related technologies to improve security. One or more highly publicized incidents could result in sudden political pressure to deploy such technologies, as happened with airport security screening devices. Investing more R&D funds in remote cargo monitoring technologies may be a prudent way to prepare for political pressures, should they arise.

Information Technology Also Increases Deployment Risks

Although information technology is a powerful positive force, there is a back edge to the sword: greater efficiency increases some risks for defense deployments and the economy.

The Drive to Squeeze Out Excess Capacity. In the last two decades, deregulation and IT combined to increase dramatically the efficiency of the U.S. transportation system. Globalization and competition intensified the effect. Waste and costs were wrung out of the system, reflected in growing intermodalism and shrinking empty back-haul rates.

The principal mode of IT improvement has been and continues to be more extensive and effective integration of information systems and operations. This applies within and between carriers and shippers, and it is the essence of supply chain integration.

Efficiency in supply chains means eliminating excess capacity – shedding underutilized equipment, infrastructure, and other resources. Long-haul irregular route truckload carriers have been arguably the best surface mode at exploiting information technology to manage their fleet operations. These firms excel at matching customer demand and fleet availability, leaving little excess capacity. Carriers also use long-term customer partnerships, built on tightly linked systems, to reduce variability in demand and thus the need for excess equipment capacity.

Manufacturers and distributors apply IT to reduce total inventories and inventory variability. Inventory improvement is a major benefit of the IT supply chain revolution and, as illustrated earlier, DoD benefits as well as industry. Less inventory volatility in the manufacturing and distribution sectors also helps transportation carriers because it dampens further the variability of demand imposed on them.

Less Excess Capacity Implies Less Elasticity for Defense Surges. One person's excess capacity is another person's slack capacity and buffer. Greater transportation efficiency implies less excess capacity available to meet the surge of a significant deployment.

There is more to the equation than numbers of assets. In many cases, carrier capacity has become more tightly coupled to customer operations. The carriers are less able – and certainly less willing – to abandon customer loads and commitments. They could incur significant damage, such as performance penalties and lost customer confidence. This implies a growing “stickiness” of commercial business that could slow carriers' responses to DoD in anything short of a declared national emergency. The trend toward diminished DoD peacetime market power reinforces this stickiness.

Economic prosperity is another contributor to the loss of elasticity. In general, fully employed capacity is harder to re-deploy to defense surges than temporarily idle capacity. Several observers and interviewees commented on the country's good fortune to be in or near a recession at the time Operation Desert Shield/Storm.

The net of these factors is the implication that the real surge capacity in each mode is less favorable than the portraits sketched earlier in this paper. The business and operating dynamics of each mode have changed, and traditional gauges may be misleading.

One could argue that tighter systems integration would mitigate these impacts because it permits better coordination between DoD, carriers, and other commercial customers. However, there are limits to the argument because, to some extent, the value of those improvements has already been harvested by divesting excess capacity. The argument has an element of double counting, of having your cake and eating it too.

A growing number of observers are concerned with – and paying attention to – the risks that less slack capacity create for military deployments. The Transportation Research Board's (TRB) Military Transportation Committee is a leading forum for the debate, as reflected in the title of its session at the TRB January 2000 Annual Meeting: "Shrinking Excess Capacity in the U.S. Transportation System and its Impacts During a Military Crisis."²⁸ The committee and its friends were sources of interviewees for this paper.

Less Excess Capacity Can Also Increase Risks for the Economy. The combination of a military surge and less excess capacity generates risks for the economy as well as for military planners. Further indirect dangers for DoD are also buried in these risks.

Wrenching commercial lift from commercial customers is never easy. Even in the Gulf War when, as one interviewee commented, the carriers showed great flexibility in providing support and USTRANSCOM showed restraint in calling on them, there were anecdotes of business penalties incurred by the supportive carriers.

In an era of tighter, leaner supply chains, it seems reasonable that transportation diversions and disruptions would cause wider, deeper impacts sooner than historical experience would suggest. The trend of increasingly sophisticated supply chain coordination began with Just-in-Time deliveries, grew in complexity to Vendor Managed Inventories, and matured even further to Make-to-Order manufacturing. The trend implies fewer buffers before widening circles of factories shut down.

Airfreight Illustrates Increased Risks for the Economy. Interviewees in the USTRANSCOM community and the aviation industry were relatively sanguine about the impact of CRAF activation on the economy. To summarize their reasoning, CRAF activation's main impact will be on long-range international aircraft. This is unlikely to affect domestic aircraft and service. According to one industry observer, in the extreme event of a CRAF Stage III activation, the domestic impact would still be manageable because DOT would take over priority allocation for remaining domestic air service.

In the view of other interviewees and observers, including the author, this assessment misses an important dynamic. CRAF carriers are obligated by contract to provide four crews for each activated aircraft, so the activation may have an impact disproportionately greater than the number of aircraft. More to the point, express carriers such as FedEx are

²⁸Bob Honea summarized that session in "U.S. Military Preparedness: Jammed in the Traffic?," *TR News*, November-December 2000.

part of the program. Pulling their LRI aircraft and crews may disrupt their total network, not just the international legs.

The most important factor is the degree to which global air express and airfreight services have become essential sinews in time-sensitive integrated supply chains. The degree of dependence on them to produce high priority items is largely invisible, and the macro impacts may be an accumulation of many small cuts, some of which cause large problems.

These problems will affect DoD, not just industry. A defense surge implies a jump in high priority requisitions. Supplier flexibility will be essential. Defense contractors will depend on express services to gather components and respond to some of those requisitions. For example, what would happen to Raytheon's ability to *produce* high priority DoD parts if Raytheon's *internal* supply chains were disrupted because CRAF reduced FedEx service? Because of the trend to supply chain integration, disruption of the air express and airfreight system is more likely to cause unanticipated problems for DoD today than it would have 10 years ago.

“Wolfe’s Paradox.” The paradox is a hypothesis that builds on the arguments of the preceding subsections: “Overall logistics systems capabilities are growing *simultaneously* more robust and more fragile.”²⁹ The defense corollary would be that “supply chains essential for strategic mobility are becoming *simultaneously* more robust and more fragile.”

Highly efficient systems are supple and robust in handling relatively small variations in supply or demand – variations within their competence and design capacity. However, those same systems can be brittle and fragile when confronted with large, sudden spikes in demand (such as a military surge) or plunges in supply (such as a United Parcel Service strike). Given reduced excess capacity, these systems cannot respond effectively far beyond their normal operating circumstances. Fragility also increases with unanticipated failures in information infrastructure such as GPS, the Internet, telecommunications, or power supply.

The defense corollary seems to be more potent than the basic paradox. Risks and pressures are greater in part because national security impacts can so exceed those of commerce. Lean inventories and JIT distribution in support of military engagements imply that the costs of transportation disruptions or logistics failures can be much more severe – measured in blood and mission failure, not just dollars. The risks and pressures may be greater still if, as some senior observers believe, future adversaries direct asymmetric attacks, such as infiltration or sabotage, against U.S. logistics lines of communication.³⁰ The direct and indirect vulnerabilities noted earlier in this paper only increase the power and importance of the paradox and the defense corollary.

The paradox does not imply a Luddite response of turning away from advanced information technology or supply chain integration. It does, however, imply two needs. First, rigorous efforts to understand the boundaries – the scenarios – that tip the balance so the

²⁹ “Technology Evolution & Its Impact on Transportation & Logistics,” annotated briefing, Volpe National Transportation Systems Center, F.L. Hassler, August 5, 1997, p. 10. Mr. Hassler named “Wolfe’s Paradox” when the author of this paper first observed and described the contradiction.

³⁰ “From Factory to Foxhole,” p. 58.

risks of fragility outweigh the benefits of robustness. Second, equally serious efforts to prioritize and mitigate the risks.

Simple adoption of best commercial practices may not be the best response within DoD or in collaboration with its business partners. For example, Direct Vendor Deliveries may be counterproductive without implementing a process to integrate DVD shipments into the Defense Transportation System in times of crisis. Similarly, Contract Logistics Services may also be counterproductive in a crisis if DoD does not rationalize parallel and potentially competing organic and contractor supply chains.

■ Issues

Assured Access to Timely Transportation Capacity

DoD must be able to acquire timely and cost-effective transportation.

National strategy, reasonably enough, calls for significantly faster schedules to deploy massive combat power. Private industry is squeezing slack capacity and excess inventories out of the system. Supply chain integration is tying carriers more closely and inextricably to commercial customers. Global competition focuses carrier and supplier managements on customer relationships and stockholder value. DoD's commercial market leverage has declined in absolute terms and will probably keep declining in relative terms.

Because of these trends and considerations, the freight transportation system seems unlikely to provide some essential services for major deployments in the timeframes called for by military leaders. This will become more of an issue as deployment timeframes become more ambitious. The critical factors are *timeliness* and the *transition* from commercial business to defense deployment.

For the initial deployment, transportation from CONUS origins to ports of embarkation appears to be more of an issue than inter-theater lift. The domestic freight system has tremendous capacity and flexibility, but there are concerns about the ability of the railroads to provide sufficient numbers of standard and heavy-duty flatcars when they are needed at power projection installations. Beneath the operational concerns, there is also a continuing need to assure adequate connecting lines to those DoD installations. On the highways, it appears that munitions-qualified trucking capacity has declined along with peacetime defense shipments, and that there is insufficient elasticity to support a major surge. Finally, there are concerns about port staging capacity.

DoD and the Congress are making important and productive investments in organic airlift and sealift, which has eased the inter-theater unit deployment problem. However, available capacity would remain a challenge if large military operations were to require massive sustainment shipments. This implies continuing issues with the VISA and CRAF programs and their industry constituencies.

The surge problems with rail, munitions transport, and port staging, if true, present a greater challenge in managing perceptions and priorities. Rail flatcars and munitions trucking lack the media appeal and spending constituencies of airlines, aircraft manufacturing, and shipbuilding.

Peacetime policy and day-to-day transportation practices have profound implications for both surge and sustainment. The issue may begin with power projection problems, but solving it will require creative and effective solutions to assure DoD's routine access to cost-effective transportation.

Potential Disruption to Civil Commerce and Defense Production

DOT and DoD must be able to support major deployments with minimum impacts on the economy and on defense production. However, there appears to be an increasing likelihood that marshalling civil transportation assets for a major deployment would unleash unanticipated problems in critical commercial supply chains. Those problems imply growing risks for both civil commerce and critical defense production.

This issue is another product of the trends and considerations summarized for the preceding issue. Increasingly aggressive deployment timeframes plus the impacts of supply chain integration and global competition imply that lift capacity diverted to DoD will have greater effects on the economy, and cause them sooner than experience would indicate. The direction of all three trends – faster deployment goals, greater supply chain integration, and globalization – implies that the importance of this issue and its risks will continue to grow.

Removing imbedded transportation from lean, just-in-time supply chains will disrupt more production, in more places, more quickly. Diverting significant numbers of long-range international civil aircraft and crews from cargo and package express services may be especially disruptive. Critical defense production is likely to be an unintended and unanticipated casualty as disruption to the commercial economy upsets the internal supply chains of defense manufacturers and maintenance providers.

This issue reflects the paradox that “overall logistics systems capabilities are growing *simultaneously* more robust and more fragile.” However, there is no clear picture of the dimensions and dynamics of these problems, nor any known systematic study of them. Addressing this issue will require a rigorous effort to understand the dynamics of the paradox and alternatives to mitigate its impact. Relevant tools may include creative macro/micro economic modeling and case studies.

Grappling with this issue could produce wider benefits. For example, DOT could use knowledge about dealing with the economy's response to demand spikes to plan for and deal with sudden plunges in supply, such as major strikes or natural disasters.

Maintaining Safety, Improving Security, and Reducing Vulnerability

This is a set of four related issues.

DoD, working together with DOT and industry, must maintain and reinforce its excellent safety record for transporting munitions and other hazardous materiel. One approach would be to encourage development and deployment of technologies to provide other modes with detailed real-time monitoring comparable to CONUS munitions motor carriers.

A related issue is to improve the physical security of munitions, weapons, classified, and high-value shipments. Although there is no indication that this is a significant problem for defense shipments today, the legitimate concern with terrorism implies it would be prudent to address the issue. In most cases, efforts to improve the monitoring of shipment safety would also improve shipment security. Collaborating with industry to control cargo theft should also contribute to the security of defense shipments.

A pressing interdepartmental issue, one already receiving increasing attention, is to understand and reduce direct vulnerabilities of the freight transportation system to asymmetric attacks, and to mitigate the effects of such attacks. This issue goes beyond threats to classical transportation features and includes supporting infrastructures, such as communications and electricity, which are critical to transportation operations. Given the complexity and extent of the risks, this issue demands interagency cooperation to assure meaningful progress.

The final issue is to better understand the indirect or second order vulnerabilities to asymmetric threats – where congestion effects or unintended consequences of security countermeasures may disrupt freight system operation. In the language of the security community, this issue is about broadening the scope of consequence management. One task related to the issue is assuring that the portions of FEMA's Federal Response Plan that address transportation are responsive to the freight transportation second order concerns.

■ A Post-September 11 Epilog

Clichés often reflect reality, and the common statement that "everything changed on September 11" puts a value on re-visiting the conclusions and judgments offered in this paper. The author considered new material and talked with selected sources in December 2001. The goal was to assess the impact of September 11 on defense logistics and transportation trends, their implications, and the open issues discussed above.

Strategic Mobility

The US defense strategy has been refined, but there is no indication that the US is backing away from more aggressive and ambitious time horizons to deploy significant combat power anywhere on the globe.

The Quadrennial Defense Review Report (QDR), released September 30, 2001, serves as DoD's overall strategic planning document as required by the Government Performance and Results Act of 1993. The QDR, prepared before September 11, was revised and modified before publication and seems to reflect the impact of the new terrorism-sensitive

environment. Increased emphasis on defense of the homeland is balanced by reemphasis of the need to project power at long distances. A QDR theme of force transformation also relates to increasing agility and lethality, consistent with the trend described in this paper.

The QDR establishes a new strategic "construct" designed "to provide over time a richer set of military options across the operational spectrum than is available today and to ensure that U.S. forces have the means to adapt in time to surprise." The new construct "restores the defense of the United States as the Department's primary mission." In terms of strategic mobility, "the approach shifts the focus of U.S. force planning from optimizing for conflicts in two particular regions - Northeast and Southwest Asia - to building a portfolio of capabilities that is robust across the spectrum of possible force requirements, both functional and geographical.

"...the new construct serves as a bridge from today's force, developed around the threat-based, two-MTW construct, to a future, transformed force. The United States will continue to meet its commitments around the world, including in Southwest and Northeast Asia, by maintaining the ability to defeat aggression in two critical areas in overlapping timeframes."³¹ A long-term objective of transformation is to reduce deployment footprints by increasing "the capability of its forward forces."³²

While the QDR does not give force deployment time goals, it clearly commits the nation to speedy deployment of significant combat power.³³ It seems fair to conclude that the first trend in this theme paper and its implication still hold: "deployment timeframes are becoming more ambitious," and "the deployment challenge [for significant forces] is becoming more difficult." Timeliness and transition remain critical factors.

Our recent experience deploying special operations forces to the Afghan Theater did not impose significant stress on the national freight transportation system, but that does not invalidate the argument. This was a quick transition but it involved relatively small forces.

USTRANSCOM established an "air bridge" for the deployment, drawing heavily on organic USAF cargo aircraft. In little more than two months, they moved 43,000 tons of cargo, supported by 2,100 air refueling missions.³⁴ DoD also drew on chartered commercial airfreighters, which were easily available because of the fall-off in commerce.³⁵

³¹ *Quadrennial Defense Review Report*, "September 30, 2001, pp. 17-18.

³² P. 20. If increasing the capability of forward forces implies larger forces overseas then, all other things being equal, it also implies a larger demand for day-to-day freight transportation services.

³³ Pp. 20-21.

³⁴ "Deputy logistics chief outlines USTRANSCOM contribution to Enduring Freedom," USTRANSCOM Release, November 30, 2001.

³⁵ On October 15, *Aviation Week & Space Technology* reported that "An estimated 80 one-way Air Mobility Command charters in recent weeks brought financial relief to some airlines that operate aircraft in the Civil Reserve Air Fleet (CRAF)." ("Cargo Carriers Look For Silver Lining.")

A more substantial deployment, such as quickly moving four fighting divisions and supporting forces to the Arabian Peninsula, would probably create transition challenges consistent with those described in the initial paper.

The Importance of DoD Business to Commercial Carriers

The second trend discussed in the paper was that "DoD is a less important customer to the freight transportation industry in 2000 than it was in 1990, and its importance will continue to shrink in relative terms, and perhaps in absolute terms as well." One implication of this trend was to sharpen the issue about assured access, in peace and war, to timely and cost-effective commercial transportation services.

September 11 injects countervailing pressures that make it difficult to fully assess this trend and its implications. First, demand is up in several sectors. Second, whether total DOD freight demand changes significantly depends on policy decisions yet to be made. Third, the wartime posture of the nation towards terrorism has to affect the calculus of US transportation firms in responding to military needs.

Two areas where demand seems somewhat increased are airfreight and munitions transportation. The Afghan deployment discussion illustrated the demand for commercial airfreight service to support special operations forces. For defense munitions, there are much more stringent security controls on shipments, and that probably combines with the expenditure of munitions overseas to add demand for carriers in that sector.

Whether aggregate demand for commercial transportation changes significantly--reversing the trend--depends on two exogenous factors. First is whether the president decides to engage significant combat forces in an area such as the Middle East. Second is whether the nation decides over time to enlarge the armed forces or increase the proportion of forces deployed overseas on a continuing basis--size and distance being determinants of ton-miles of demand.

On balance, it seems fair to conclude that the absolute decline in military demand for commercial transportation is over. Whether relative demand continues to shrink depends on a resumption of vigorous economic growth in developed and developing nations.

Integration with Industry

The third trend seems to continue unabated: defense and commercial supply chains are becoming more integrated. The author asked several senior defense transportation officials if exposure to terrorist disruption might lead to a re-thinking and a separation of DoD and commercial supplier and carrier systems and business processes. In each case, the response was that interdependence would continue to increase, that DoD was even more dependent upon commercial industry, and the decision would be to move forward.³⁶

³⁶ Individual sources are not identified to be consistent with non-attribution commitments made when researching the basic paper.

Collaborative programs between DoD and industry yielded significant improvements in delivery times in 2001 over a baseline of 2000. The Strategic Distribution Management Initiative (SDMI), addressed in the original report, reduced customer wait times and total delivery times for surface shipments by fifteen percent over a year ago. "Whether routine sustainment supplies or critical spare parts ... deliveries [are] faster than ever. As an example ...Southern Command receive[s] freight ... in 36 days instead of the previous 47 days [in 2000].³⁷

It seems fair to question whether these dramatic improvements will continue post-September 11. First, most if not all of the data reported above reflects pre-September 11 experience. Second, SDMI rests on "synchronization of freight through the entire logistics process" and pre-coordination of intermodal transfers. As we will discuss below, security activity has disrupted freight operations and increased unpredictability. It seems likely that SDMI's 2002-over-2001 data will be less positive.

Increasing operational challenges, however, do not imply an end of the trend towards more integration. According to published reports, speakers at the Defense Logistics 2001 Conference in December 2001 gave every indication that the trend is intact.³⁸

Safety and Security

The broad statement of the fourth trend, "sensitivity to some safety and security issues is increasing," is still correct, but quite an understatement. September 11 quite properly focused attention on potential terrorist threats both to US armed forces and installations, and to turning military materiel and transport into instruments of terror directed at civilians and civil infrastructure. There has been a watershed change, increasing the sense urgency and devotion of resources to what DoD calls Force Protection.

Detailed information about Force Protection measures is hard to obtain for public consumption. Operations security practices, or OPSEC, intentionally limit public information. As one security officer put it, "OPSEC is all about denying the bad guys information so we can protect personnel and mission effectiveness."³⁹ Therefore, some of the following discussion may seem rather general.

Critical Infrastructure Protection

The paper described a significant increase in sensitivity to and concern about direct vulnerability to disruption well before the events of September 11. Of course, attention is now much greater.

Increased Force Protection is evident at the gate of every defense installation, where access and inspection controls have increased by an order of magnitude. Physical barriers are

³⁷ USTRANSCOM new release of October 26, 2001, "Initiative speeds defense freight worldwide."

³⁸ The theme shows up repeatedly in a report by AMR Research, an electronic commerce consultancy. *AMR Research Alert*, December 17, 2001, "Interoperability Will Keep Defense Logistics in Motion."

³⁹ USTRANSCOM news release, September 26, 2001, "OPSEC critical every day, everywhere."

greater, protective forces are more numerous and obvious, clearance procedures more thorough and limiting, and many bases have been closed to visitors.

Procedures are not uniform. Delays can be significant and variable, and this has had an impact on the schedule reliability of freight shipments in and out of defense installations. For example, Federal Express informed DoD officials that they cannot meet contract standards for small package delivery times because of the delays and variability caused by tighter inspections of trucks and packages entering posts and bases.⁴⁰

Infrastructure protection extends beyond installation gates. For example, MacDill AFB in Florida sits on a peninsula and the Air Force, working with Coast Guard, established a 1000 yard security zone that is to remain clear of boats at all times.⁴¹ Systematic programs, such as the Transportation Engineering Agency's Transportation Infrastructure Criticality and Vulnerability (TRI-CAV), gain greater visibility. Given DoD's modal transportation programs to assure transportation infrastructure availability between Power Projection Platforms and ports--Highways, Railroads, and Ports for National Defense--one may take for granted that there is closer coordination between DoD, transportation firms, and all levels of civil government to protect bridges and tunnels that are critical to DoD.

Hazardous and Sensitive Shipments

The original report described DoD's close attention to the safety and security of hazardous and sensitive shipments--including the pride with which munitions transportation officials describe their micromanagement of highway shipments in the continental US. Since September 11, DoD moved aggressively to increase control and security.

DoD's response in this area was galvanized by a General Accounting Office report issued in May 2001. The report criticized security lapses and failures at en-route layover facilities and terminals. For example, trailers were not always sufficiently guarded or secured. The report was so detailed that, soon after September 11, it was withdrawn from circulation and classified. Senior defense transportation officials, testifying in closed Congressional hearings on October 16, thanked the GAO for calling the situation to their attention and described significant corrective actions.⁴²

The shipments in question include the highest risk categories. Category I, for example, is most sensitive and includes man-portable non-nuclear missiles in ready-to-fire configurations.⁴³ In addition to mandatory satellite monitoring, military armed guards now accompany all such shipments and, apparently, many in Categories II-IV as well. The escorts are trained and certified to carry weapons if warranted by threats conditions.

⁴⁰ Personal conversation with a senior defense transportation official.

⁴¹ USTRANSCOM new release, November 23, 2001, "Homeland Defense Coast Guard security zone, boat registration keeps MacDill mariners safe."

⁴² Personal conversation with a senior defense transportation official. Details on the corrective actions are not public information.

⁴³ A complete table of "Transportation Protective Service (Motor)" can be found under that title on the Military Traffic Management Command's web site. There are twelve codes.

The array of permissible stop points en route is drastically reduced. A former Commander-in-Chief of USTRANSCOM said the number of allowed nodes for such shipments has been reduced from the hundreds to the dozens, and that the goal is to reduce it to single numbers.⁴⁴

The operating flexibility of the munition carriers is reduced. More drivers must have Secret clearances. Carrier free time after pickup--the permissible time during which carriers may hold trailers in their own terminal prior to dispatch--is reduced to four or fewer hours. Total shipment time windows appear to be shortened by half.

These security improvements have non-trivial cost implications. The MTMC has already approved security-related rate increases for munitions carriers that seem to average over 20%. For example, rates from Anniston Ammunition Depot to all destinations increased between 21 and 24%. Some rates for shipments in vans increased 39 cents per mile on a base of \$1.60, while some rates for shipments in dromedary containers increased 25 cents on a base of \$1.00.⁴⁵ The rate increases only address the carriers' costs, not costs borne by the government--such as the use of military escorts --or by the shippers. (As of December 18, 2001, MTMC has not approved any security-related rate increases for general motor freight.)

Indirect Vulnerability to Disruption

The pre-September 11 version of the paper asserted that "The trend line in sensitivity to safety and security related to defense freight transportation varies by segment.... The third segment, indirect vulnerability to disruption, hardly appears on any radar screen."

Indirect risks are usually caused by protective and preventive reactions to terrorism rather than by terrorist events themselves. The risks "include significant increases in congestion and confusion [or unpredictability] that interfere with either critical defense production or transportation operations." The original version of the paper offered two illustrations that resonate today: the potential secondary effects of a successful terrorist attack on the World Trade Center and the smuggling of a weapon of mass destruction in a commercial cargo container.

Characteristics of information technology as applied to logistics may compound the indirect risks. The paper offered the hypothesis that logistics systems are becoming simultaneously more robust and more fragile, that sudden spikes up in demand or down in supply can be uncommonly disruptive. Drastic or unexpected increases in security measures--secondary impacts--could equate to a sudden downward spike in available supply, triggering disproportionate impacts in very lean supply chains.

⁴⁴ Personal conversation.

⁴⁵ Information provided telephonically by the Joint Traffic Management Office, which considers the Anniston rate increases to be typical.

The major threats of indirect impacts range throughout the economy. Defense capabilities could be impaired by disruptions to either the supply chains of defense contractors or to direct DoD operations.

Awareness of indirect impacts is much higher since September 11, as reflected in and increased by many press reports of border delays, congestion, modal diversions, and delays due to increased security. The FedEx and munitions security examples given above also illustrate the awareness of indirect impacts in the Defense Transportation System.

There is a healthy concern in many quarters about the impact of security measures on productivity and the importance of designing protective measures that reinforce supply chain effectiveness and efficiency.⁴⁶ The issue is also clear to defense transportation leaders. For example, the National Defense Transportation Association arranged a multimodal CEO-level working session on security at USTRANSCOM, and the impacts of security measures was a recurring theme.⁴⁷

The original paper discussed FEMA's Federal Response Plan as a possible venue to address mitigation of second order transportation impacts. It seems clear that today the plan deals only with response to and recovery from direct incidents.⁴⁸

Heightened awareness and concern about secondary impacts are positive changes from pre-September 11.

Revisiting the Issues

Assured Access to Timely Transportation Capacity

The fundamental issue is still "DoD must be able to acquire timely and cost-effective transportation." As discussed in the body of the paper, the greatest challenge remains with deployment and sustainment of significant combat forces actively engaged with an enemy. However, the events of September 11 inform this issue in at least three ways.

First, engagements limited to special operations forces, as in the Afghan theater, seem unlikely to put severe stress on the transportation system or to create great challenge in acquiring timely and cost-effective transportation. The only possible exception would be in times of very robust commercial demand for airfreight that was not undercut by an increase in the tempo of defense movements.

⁴⁶ Three disparate illustrations of this concern include statements of Transportation Secretary Mineta (such as before the House Subcommittee on Coast Guard and Maritime Transportation, December 6, 2001); a *Newsweek* column by Fareed Zakaria ("Time to Save 'Just in Time,'" November 12, 2001, p. 38); and the chartering of this author by FHWA to prepare a theme paper on "Freight Transportation Vulnerability, Security, and Productivity."

⁴⁷ The session took place December 10, 2001. Two sources provided information to the author.

⁴⁸ DOT's Office of Emergency Transportation is the DOT focal point for interaction with FEMA and implementation of the Federal Response Plan. Discussions with two OET officials support the conclusion that the plan focuses on direct impacts.

Second, DoD's access has improved because of an important qualitative or psychological factor: the nation's shift to a protracted war-like footing. Patriotism and broadly defined self-interest drive transportation industry leaders to support the needs of the defense establishment in times of war and crisis and, after September 11, the nation appears to be in an extended crisis.

Third, vulnerability to direct and indirect impacts of terrorism add more facets of risk to the issue of assured access of timely transportation capacity. Healthy business conditions and relationships between DoD and commercial carriers are necessary but not sufficient ingredients to guarantee assured access. The issues discussed below reinforce the challenge of assured access.

Potential Disruption to Civil Commerce and Defense Production

The second issue discussed in the paper focused on "an increasing likelihood that marshalling civil transportation assets for a major deployment would unleash unanticipated problems in critical commercial supply chains. Those problems imply growing risks for both civil commerce and critical defense production." "Removing imbedded transportation from lean, just-in-time supply chains will disrupt more production, in more places, more quickly."

The issue remains relevant to major deployments, but one lesson of September 11 and its aftermath is that the same vulnerability exists to the impacts of terrorism—both the direct effects of major events that might close ports such as Los Angeles/Long Beach or New York, and indirect effects of significant increases in countermeasures.

Maintaining Safety, Improving Security, and Reducing Vulnerability

This set of four related issues remains valid, but the importance of the final three items is increased. The set includes:

1. DoD and its partners in "DOT and industry, must maintain and reinforce [the] excellent safety record for transporting munitions and other hazardous material."
2. DoD, its carriers, and law enforcement officials must "improve the physical security of munitions, weapons, classified, and high-value shipments."
3. There is a national need "to understand and reduce direct vulnerabilities of the freight transportation system to asymmetric attacks, and to mitigate the effects of such attacks."
4. There is a national need "to better understand [and mitigate] the indirect or second order vulnerabilities to asymmetric threats – where congestion effects or unintended consequences of security countermeasures may disrupt freight system operation."