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Crisis management: operational logistics and asset visibility technologies

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NAVAL POSTGRADUATE SCHOOL

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MBA PROFESSIONAL REPORT

Crisis Management- Operational Logistics & Asset Visibility Technologies

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June 2006

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The purpose of this MBA Project was to identify and explore logistical frameworks that leverage technology to overcome problems associated with coordinated logistics operations during crisis management. Over the past ten years, there have been significant advances in RFID, satellite and other related asset visibility technologies. These advances are mature enough to significantly increase the probability of achieving a useful common operational picture during emergency response activities. Recent crisis response operations that would have benefited from improved asset visibility include the Indian Ocean tsunami, the Pakistani earthquake, Hurricane Katrina and those related to the Global War on Terror. In each of these cases, multi-agency involvement, both foreign and domestic, compounded the complexity of asset tracking and communication protocols. The establishment of a logistics-tracking framework that provides adequate asset visibility, while maintaining operational security, will greatly increase the effectiveness of future crisis response operations. The proposed logistics framework serves as a viable solution for common logistical problems encountered by the U.S. and other industrialized nations while conducting crisis response operations. The framework identifies concepts, technologies and protocols that can be used to improve crisis operations on a global scale.

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CRISIS MANAGEMENT- OPERATIONAL LOGISTICS & ASSET VISIBILITY TECHNOLOGIES

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ABSTRACT

The purpose of this MBA Project was to identify and explore logistical frameworks that leverage technology to overcome problems associated with coordinated logistics operations during crisis management. Over the past ten years, there have been significant advances in RFID, satellite and other related asset visibility technologies. These advances are mature enough to significantly increase the probability of achieving a useful common operational picture during emergency response activities. Recent crisis response operations that would have benefited from improved asset visibility include the Indian Ocean tsunami, the Pakistani earthquake, Hurricane Katrina and those related to the Global War on Terror. In each of these cases, multi-agency involvement, both foreign and domestic, compounded the complexity of asset tracking and communication protocols. The establishment of a logistics-tracking framework that provides adequate asset visibility, while maintaining operational security, will greatly increase the effectiveness of future crisis response operations. The proposed logistics framework serves as a viable solution for common logistical problems encountered by the U.S. and other industrialized nations while conducting crisis response operations. The framework identifies concepts, technologies and protocols that can be used to improve crisis operations on a global scale.

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I. INTRODUCTION

As evidenced by recent large-scale disasters, there are significant shortfalls with regard to the emergency response capabilities of the United States and the international community. In the U.S., the response to Hurricane Katrina uncovered several systemic problems associated with coordinated logistics. These problems hindered the ability of response professionals to create an atmosphere of trust and confidence among those affected. Logistical failure was recognized as a major contributing factor to the overall response breakdown, particularly the absence of reliable, secure and appropriately transparent asset visibility. By asset visibility we mean the capability of crisis response personnel to access timely and accurate information regarding the location, status, identity, and requirements associated with available resources (The White House, 2006, p 44).

Coordinated logistics is a pivotal component in the conduct of effective crisis management. The goal of coordinated logistics should be to maximize efficiency with respect to the allocation of available resources. In order to achieve this, the right people within each agency or organization need to be communicating and monitoring the same situational picture. Done well, multi-agency coordination can provide a tremendous positive impact. Done poorly, it may yield severe negative results. This research identifies and explores relevant technologies and their potential roles within existing and developing frameworks designed to facilitate coordinated response to large-scale crises. In recent years, there have been significant advances in RFID, satellite and other related asset visibility technologies. Of particular value are technological advances that increase the probability of achieving a useful common operational picture during emergency response activities.

The overall effect of multi-agency involvement has served as a primary trigger for our research. The level of simultaneous interaction required from various diverse entities compounds the complexity of asset tracking and related communication protocols. As a mitigating factor, it is imperative to maintain an appropriate focus on the concept of “open architecture" because it encourages and facilitates modularity, economies of scale and decreased learning curves, all factors that contribute to lower costs. Doing so will have a profound effect on the costs associated with emerging and developing technologies. The establishment of a logistical framework built on the concepts of open architecture, reliable asset visibility, and operational security, will greatly increase the effectiveness of future crisis response operations and provide the assurance that is necessary for the success of any crisis response system.

Given the state of technology in today's world, there is no reason why governments should not be able to provide better crisis response. Wildfires, earthquakes, tornados, hurricanes, tsunamis, and terrorist attacks are all realities throughout the world. Some question the United States' ability to respond effectively. Others believe that America has strong logistical capabilities with respect to crisis management. Despite the shortfalls of the Katrina disaster response, the tools and resources to achieve the desired state of readiness already exist and could be exploited. Whether or not the right decisions will be made, depends on the leadership at the highest and most critical levels. The U.S. has implemented innovative logistics solutions in the past. The Liberty Ships and the Pacific Campaign of WWII, the Berlin Airlift, and the Desert Storm pre-invasion build-up are a few examples. But, as we all have probably experienced, you are only as good as your last failure. It is now time to set forth on the next large-scale innovative logistical solution. The logistical frameworks and associated technologies that are explored can provide the groundwork and background for improved crisis response programs in the U.S. and throughout the world.

II. LOGISTICS DURING CRISIS MANAGEMENT

A. ASSET VISIBILITY AND THE COMMON OPERATIONAL PICTURE

Relief efforts in response to recent large-scale disasters such as the Indian Ocean Tsunami (December 2004), Hurricane Katrina (August 2005) and the Pakistani Earthquake (October 2005) have confirmed the need for more effective logistics operations during crisis response.

A study conducted by the Fritz Institute, a San-Francisco based non-profit organization that works with humanitarian relief organizations and the private sector to identify solutions to complex operational challenges, concluded that the Tsunami relief effort was marred with logistical problems. Some 100 officials in charge of logistics operations were surveyed at 18 of the largest humanitarian organizations that participated in relief operations. Sixteen of these organizations reported that at the time of the disaster, they suffered from shortages of experienced logisticians within the South Asian region. Only 5 of the organizations claimed to have access to integrated computer software that allowed for the tracking of resources. Many of the groups did the best they could with what they had, tracking resources manually or through the use of generic spreadsheet programs. The survey also found that, while many of the organizations made an effort to coordinate with local authorities and the military, only about half reported efforts to coordinate with other relief agencies. This lack of coordination is believed to have contributed to many of the logistical bottlenecks that hindered relief operations (Jensen, 2005).

Considerable advances in communication, satellite and RFID technologies offer viable solutions to several traditional logistical problems. Reliable in-transit visibility, coupled with improved interagency communication and coordination, has the potential to provide significant benefits to all stakeholders. The need for these benefits is especially apparent during the critical life-saving hours following a disaster. The proper application of in-transit visibility can greatly increase the probability that a useful common operational picture will be achieved during crisis response operations. Without it, the chances of providing assurance during chaos will be significantly diminished.

A common operational picture allows identical, relevant information to be shared by more than one command, agency or authority. It facilitates collaborative planning and coordinated operations by providing all echelons the ability to achieve a high level of situational awareness (Joint Chiefs of Staff, 2003, p GL6). Relevant information could be as broad as a nation's entire stock of small pox vaccination and as detailed as the last known location of a pallet of Meals-Ready-to-Eat (MREs). While conducting crisis management activities, critical time sensitive information could be the difference between chaos and order. Within the Logistics function of an Incident Command Center, asset visibility is the key component that contributes to a useful common operational picture. The figure below illustrates how systems and agencies linked by an integrated communications network can use and share information about resources, thereby allowing accurate, real-time asset visibility, a key requirement in the effective flow of material logistics.

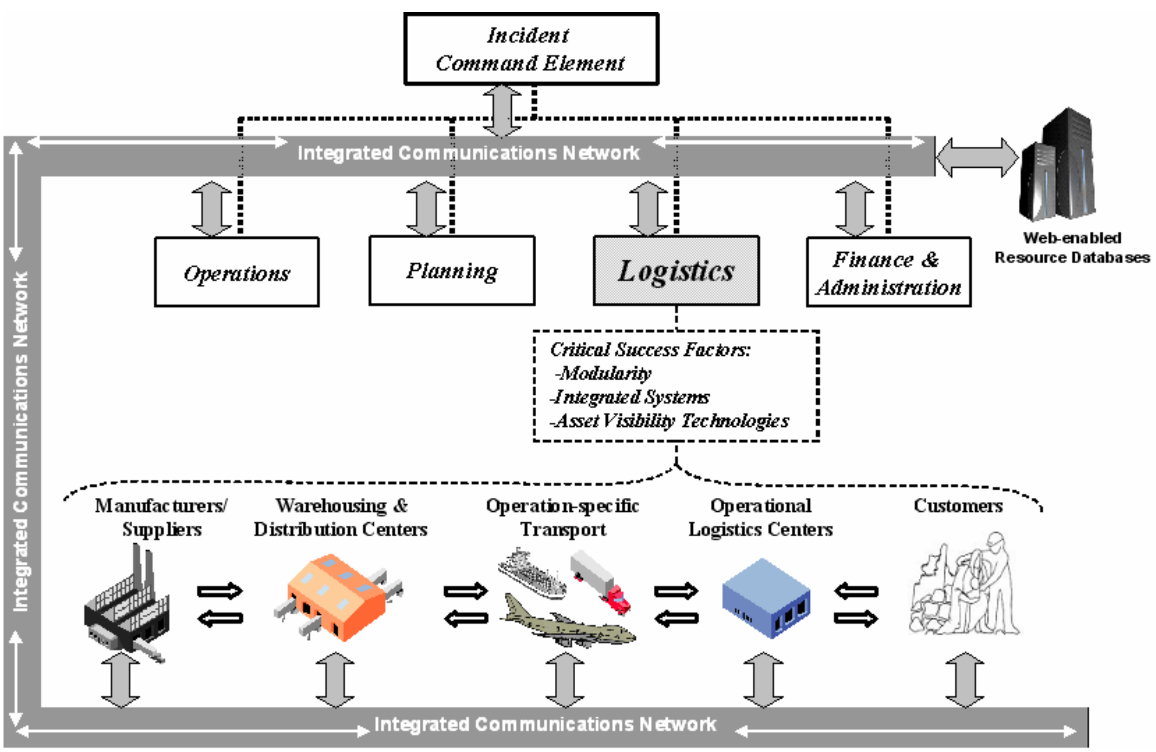

Figure 1. Conceptual Integrated Framework (adapted from DSCC, 2005; NIMS 2004; NRP, 2004)

B. LOGISTICS OPERATIONS IN SUPPORT OF HURRICANE KATRINA

To identify the most promising courses of action for the implementation of an integrated crisis response logistics model, we must glean insight from the most advanced existing frameworks. Equally important is recognizing the most recent and comprehensive example of crisis response where these frameworks were fully tested.

Several serious concerns were publicized during the Hurricane Katrina disaster that led to the perception of an ineffective federal response system. The sheer magnitude of the storm was such that certain effects of its power were impossible to effectively mitigate (The White House, 2006, p 34). However, tools that could have mitigated many negative effects of the storm and its aftermath were not exploited (Newman, 2006). Although there were few deaths from long-term exposure or starvation, and there was a minimal international response, Hurricane Katrina is a useful case study. This particular disaster tested and pushed many response functions to and, in many cases, past their breaking points. State-of-the-art response assets and protocols were employed on a large scale, and there were unprecedented levels of media coverage and data to analyze (Reuters, AlertNet. 2005).

Logistical tracking is one of the only major shortcomings that former FEMA director Mike Brown pinpointed during the September 27th 2005 congressional hearings held to "*Investigate the Preparation for and Response to Hurricane Katrina*" (Library of Congress Congressional Record, 2005). Logistical tracking becomes increasingly important as the size and scope of the subject disaster increases. If a disaster only covers a square mile, most logistics can likely be disbursed from one central and secure location. As the disaster area increases, there is a greater requirement for more complex logistical tracking and planning. Because assistance from FEMA and other federal agencies is more commonly required during large scale emergencies, logistics tracking is a central concern in FEMA's coordination role. If assets cannot be tracked, coordination by FEMA or anyone else is effectively unattainable.

In addition to the Congressional Hearings, there was tremendous pressure to provide further answers as to why Katrina relief efforts were inadequate. In response, the

Whitehouse published The Federal Response to Hurricane Katrina, Lessons Learned in February of 2006. Numerous logistics-related issues cited in the Lessons Learned document demand an increased effort to transform the way in which coordinated logistics is conducted. The following excerpts emphasize the need for significant Department of Defense (DoD) involvement, improved logistics tracking systems and overall asset visibility.

1. Logistics-Related Recommendations Following Hurricane Katrina

The DoD has the most sustained experience in conducting contingency operations. Its inherent culture of discipline and regulations is well-suited for immediate response activities.

> *The DoD and the Department of Homeland Security (DHS) should plan and prepare for a significant DoD supporting role during a catastrophic event. The DoD's joint operational response doctrine is an integral part of the national effort and must be fully integrated into the national response at all levels of government. DoD should have a contingency role and a requirement to assist DHS with expertise in logistics, planning, and total asset visibility* (The White House, 2006, p 94).

The National Guard has an accepted and tried role in crisis response. They have ties within their own state and neighboring states that provide them with insights less likely achieved by standard national U.S. military forces. Many capability limitations inherent within the National Guard can be met through the use of designated federal military personnel and resources. In order to realize these capabilities, a structure must be created to optimize cooperation and coordination.

> *DoD should consider fully resourcing the Joint Task Force State Headquarters to address capabilities gaps and to enhance readiness. Enhance National Guard capabilities by resourcing and fully implementing Joint Force Headquarters (JFHQ) State. JFHQ-State transformation is key to rapid deployment of National Guard forces in response to a catastrophe* (The White House, 2006, p 95).

Asset visibility can be achieved using common standards throughout the integrated supply chain. As part of a useful common operational picture, asset visibility positively contributes to decision-making processes by allowing the most efficient allocation and distribution of life-saving resources.

> *The Department of Homeland Security, in coordination with State and local governments and the private sector, should develop a modern, flexible and transparent logistics system* (The White House, 2006, p 98).

Many commercial products were offered to FEMA during the Hurricane Katrina response. The difficulties of entering these items into the federal supply chain left many of them unutilized. Compatible asset visibility systems increase the likelihood that items donated by or purchased from commercial business entities concurrent to the crisis response will be effectively managed.

> *DHS should partner with State and local governments, other Federal agencies and the private sector to develop an efficient, transparent and flexible logistics system for the procurement and delivery of goods and services during emergencies. "The new logistics system developed in concert with State and local governments, and the private sector should be transparent to all managers within the system (Federal, State and local governments and the private sector). The system should be comprehensive so that the full range of logistical requirements and the flow of goods and services can be tracked from provider to receiver* (The White House, 2006, p 98).

In any operation, there is value in clearly defining hierarchical and cooperative relationships among all stakeholders. For crisis response activities, this becomes even more important because time spent deciding who should make decisions is critical time wasted.

> *DHS should establish a Chief Logistics Officer to oversee all logistics operations across multiple support functions. The Chief Logistics Officer (CLO) would be responsible for developing and maintaining an integrated supply chain management system. This system should be structured in ways that are compatible with the structure of the National Incident Management System. The CLO would be responsible for logistics technology and software solutions that allow emergency managers to have visibility of all assets in the supply chain and to be able to access those supplies. A CLO should also be established in each homeland security regional office* (The White House, 2006, p 99).

Drawing on the DoD's experience in developing logistics systems for the DHS will reduce friction and miscommunication among all crisis response agencies. Cooperation between the two agencies before a disaster will provide critical benefits toward cooperation during a disaster. Personnel exchange programs are an effective way to achieve this working relationship in a sustaining manner.

> *DoD should detail logistics planners to DHS to assist in developing this logistics system. DoD and DHS should review and consider supply chain management best practices in developing the DHS logistics system. DoD should assist DHS in developing its logistics system; train DHS personnel in logistics management; exercise the DHS logistics system; and assist operating DHS' logistics management system until a fully mature capability exists* (The White House, 2006, p 99).

The sovereignty of State governments in managing crises within their own State is a critical concept in any process transformation that incorporates changes in the Federal scope of action or authority. Incentives may be needed to pressure States into accepting and meeting Federal requirements.

> *DHS should require State and local governments, as a condition for receiving Homeland Security grants, to develop, implement, and exercise emergency evacuation plans and to cooperate fully with all Federal evacuation activities. Consideration should be given to revising the Stafford Act to restrict reimbursement eligibility to only those States that have met basic performance requirements for critical functions such as mass evacuation* (The White House, 2006, p 100).

The need for DoD integration in hurricane response is not a post-Katrina concept as some of the previous excerpts imply. The need for transformational integration of DoD assets was recognized prior to Katrina. The excerpt below shows the concerted yet underdeveloped attempt to coordinate FEMA and the DoD. Within this limited cooperative framework, the DoD was still able to provide useful asset visibility support to FEMA during the Hurricane Katrina response.

> *Well before Hurricane Katrina struck the Gulf Coast, the Department of Defense (DOD) prepared for the 2005 hurricane season. Based on prior assistance for hurricane recovery operations, on August 19th the Secretary of Defense approved a standing order to prepare and organize for severe weather disaster operations. This order expedited the*

> *pre-positioning of senior military representatives known as Defense Coordinating Officers, to act as liaisons with other governmental organizations in the projected disaster area prior to an event. The order also authorized the use of DOD installations as logistical staging areas for FEMA. U.S. Northern Command directed a number of emergency deployment readiness exercises prior to FEMA requests, spending training funds to preposition response capability. Once officially activated and deployed, DOD provided logistics support to FEMA, helping the Agency to track items in motion* (The White House, 2006, p 130).

The Federal Government has explored, and become more knowledgeable about, existing deficiencies and corresponding solutions. Logistics, command structure, discipline and heavy DoD involvement are major themes of the Katrina Lessons Learned document. While this government document provides a realistic assessment of the situation during the Hurricane Katrina relief effort, other sources are needed to provide a complete picture.

2. Redundancy and Communications

During an emergency, responders often do not have the luxury of time to recover from a system or device failure. If an asset tracking device or system fails, the emergency situation will likely be over before repairs or remediation can be put into place. Additionally, if time is spent on recovering the tracking system, the lost time may hinder operations to the extent that it would be better to do without the tracking system altogether. When a system fails, it is often better to move forward using any redundant tracking system available, even if it does not provide the accuracy, timeliness or clarity of the primary system (Nutting, Interview, 2005).

One way to achieve redundancy in asset tracking is through the duplication of functionally identical tracking devices or systems. An example of this would be the placing of four passive RFID tags per pallet of a tracked asset. This arrangement will allow each of the pallets' vertical sides to have a tag, thus affording quicker reading without searching for a tag. This also allows item identification if one or more of the tags is damaged or obscured. Another way that redundancy can be achieved is to utilize distinct and dissimilar tracking devices and systems. For example, the use of passive RFID tags on a pallet could be bolstered by a satellite transponder on the trailer that contains the pallet. Additionally, the truck that is moving the trailer may use CB radio or a cell phone to provide regular location updates. This practice of using redundant means of communication can be very important during various emergencies where communication system failures are common.

During natural disasters, as in traditional military operations, conditions exist that can easily disable required power supplies and communication equipment. If backup systems are concurrently operating or can be quickly brought on line, the mission can continue with limited adverse interruption. One way to minimize the necessity for redundancy is through the strengthening of existing or future logistics tracking systems. A good example of this is the use of mobile satellite communications, which are less vulnerable to probable threats.

3. Decision Support Systems

Good decision making requires accurate information processing. Too much disorganized information can create a significant challenge during emergency response efforts because excess information can over-saturate those who are trying to make decisions. Precise and highly pertinent information promotes effective decision making, especially in emergency situations. If decision makers spend too much time evaluating exhaustive amounts of unrefined information, they may have insufficient time to effectively act on that information. The use of Automatic Information Systems can help collect, refine, and present large amounts of raw data that can be transformed into actionable information.

A properly implemented Automatic Information System is essential to achieving an effective common operational picture. An Automatic Information System is composed of system software and hardware that provides for collection, storage, retrieval, processing and sharing of data and information. If an Automatic Information System is designed and implemented properly, it can support most operational scenarios. If not, it can drain time and effort without the essential pay back. There must be confidence and buy-in by those using the system so they take the time to properly input and use the information. Quality outcomes depend on quality inputs.

4. Information Security

Hurricane Katrina has made it evident that information held by local officials can be dangerous and hamper relief efforts. During the Hurricane Katrina relief effort, there were several instances where logistical tracking information in the wrong hands could, and sometimes did, have negative affects. In a letter by Terry Maddox, the publisher of Slidell Sentry-News, it is described how “Parish President Davis threatened to take all available parish law enforcement personnel, as well as members of the general public, to go to Baton Rouge to hijack FEMA trailers for our displaced citizens.” (Maddox, 2005). This sort of vigilante behavior is very dangerous and appears to have hampered relief efforts (Chenelly, 2005). What might a rogue parish president do if he knew there was a truck containing generators and fuel traveling through his parish on its way to a distant distribution point?

On the other hand, information can instill trust and promote cooperation between victims and the emergency responders. If the public and officials know that supplies are heading into their area, they can respond in numerous constructive ways. Victims can clear and prepare distribution centers. Uninjured citizens can bring injured victims to areas where medical supplies will be arriving. If it is known that required supplies are not going to arrive, the local population or leaders can make decisions to conduct an evacuation or ration existing supplies. If trust is maintained, disaster victims are more likely to employ shopping carts to transport the injured and relief supplies, and they are less likely to use those carts for looting. Any time the victims can be made part of the solution, they are less likely to exacerbate the problem. Therefore, serious attention needs to be given to public distribution of information as well as distribution of information to federal, state, and local agencies. To determine how best to address these concerns, we first consider the logistics functions of current response models.

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III. CURRENT CRISIS RESPONSE LOGISTICS MODELS

The design of effective logistics tracking systems is highly dependent on the hierarchical and communication structures utilized by the relevant crisis response agencies. The United States and the United Nations both have significant disaster response entities that require complex levels of logistical protocols. Each has realized the need to restructure their logistics entities to benefit from a more coordinated and functional response. Therefore, it is important to analyze how asset visibility technologies work within organizational structures in order to achieve the best results. In some aspects, the U.S. and the UN have developed and implemented technology to fit their organizational structures. In other aspects, they have changed their organizational structures to better meet available technologies. We will now look at how each is currently organized with respect to logistics operations during crisis response.

A. U.S. CRISIS RESPONSE MODEL

The organizational model for the U.S. is based on the concept of handling incidents at the lowest possible organizational and jurisdictional level. Depending on the nature of the crisis, that level might be the local police department or it might be the U.S. Coast Guard. For federal emergency management purposes, the U.S. is broken down into 10 regions (see Figure 2).

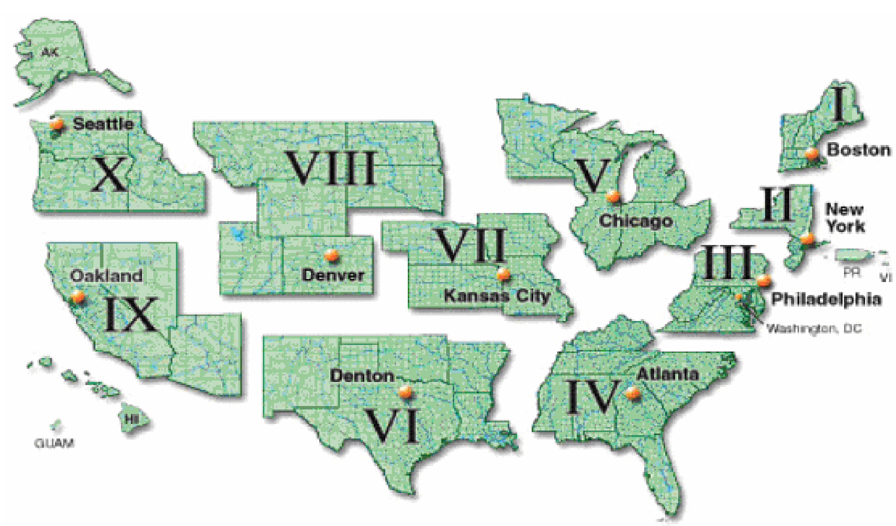

Figure 2. Federal Emergency Management Regions (USDHS, 2006)

Within each of these 10 regions are pre-positioned federal and state assets. During a large-scale disaster, various agencies compete for many of the same resources. The designated agencies alone provide 15 separate emergency support functions (ESFs) at various levels of government (see Table 1).

	ESF	Primary Department or Agency
ESF #1	Transportation	Department of Transportation
ESF #2	Communications	DHS (Information Analysis and Infrastructure Protection/National Communications System)
ESF #3	Public Works and Engineering	DoD (US Army Corps of Engineers) and DHS (Federal Emergency Management Agency)
ESF #4	Firefighting	US Department of Agriculture (Forest Service)
ESF #5	Emergency Management	DHS (Federal Emergency Management Agency)
ESF #6	Mass Care, Housing, and Human Services	DHS (Federal Emergency Management Agency) and the American Red Cross
ESF #7	Resource Support	General Services Administration
ESF #8	Public Health and Medical Services	Department of Health and Human Services
ESF #9	Urban Search and Rescue	DHS (Federal Emergency Management Agency)
ESF #10	Oil and Hazardous Materials Response	Environmental Protection Agency and DHS (US Coast Guard)
ESF #11	Agriculture and Natural Resources	US Department of Agriculture and the Department of the Interior
ESF #12	Energy	Department of Energy
ESF #13	Public Safety and Securtiy	DHS and the Department of Justice
ESF #14	Long-term Community Recovery and Mitigation	US Department of Agriculture, Department of Commerce, DHS (Federal Emergency Management Agency), Housing and Urban Development, Treasury, and the Small Business Administration
ESF #15	External Affairs	DHS (Federal Emergency Management Agency)

Table 1. Agencies Competing for Resources (The White House, 2006, p 16)

When asset visibility is poor, and the perception of scarce resources is high, inefficiency with respect to distribution increases. Support agencies may tend to hoard resources in an attempt to ensure their own sustained operations. Without a common operational picture, response professionals are unable to maximize efficiency when making decisions with respect to resource allocation.

In February of 2003, President Bush, in an attempt to strengthen U.S. Homeland Security, issued a Presidential Directive to the Secretary of Homeland Security. Within the order, the Secretary was directed to:

a. *Create a comprehensive National Incident Management System (NIMS) to provide a consistent nationwide approach for Federal, State, and local governments to work effectively together to prepare for, respond to, and recover from domestic incidents, regardless of cause, size, or complexity* (The White House, 2006, p 12) and

b. Develop and administer an integrated National Response Plan (NRP), using the NIMS, to provide the structure and mechanisms for national level policy and operational direction for Federal support to State and local incident managers (The White House, 2006, p 12).

The presidential order further directed all Federal department heads and agencies to adopt and use the NIMS as well as assist the Secretary of Homeland Security in its development and maintenance (NIMS, 2004). Completed in early 2004, the National Incident Management System and the National Response Plan provided a foundation for how the Federal Government would organize itself when called to respond to crises (NIMS, 2004).

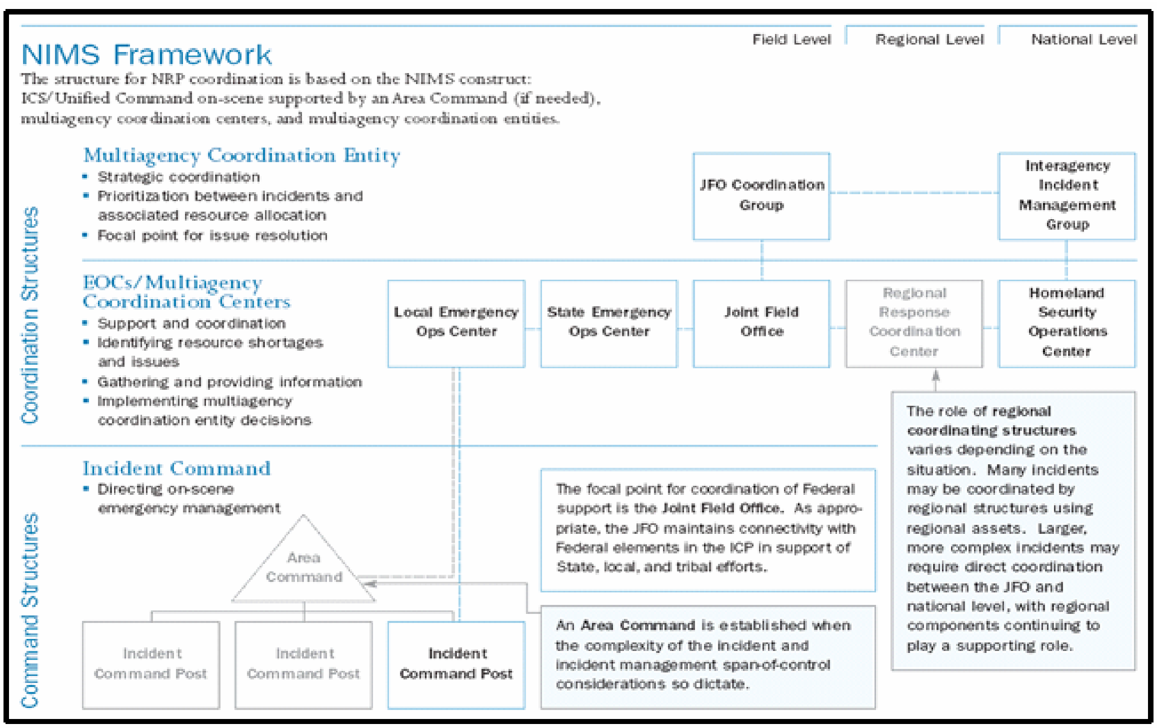

Figure 3. National Incident Management Systems (NRP, 2004, p 19)

An integral and key element of the NIMS is the Incident Command System (ICS). Refined and developed over many years, the concept of the ICS can be attributed to the challenges associated with interagency coordination while fighting wildfires in the western U.S. It had been successfully implemented at the federal, state, and local levels for some time prior to being incorporated into the NIMS (NIMS, 2004). The effectiveness of the ICS is a result of its organizational structure that can be customized to manage incidents of varying complexity and size. One main goal of the ICS is to clarify reporting relationships, thus eliminating confusion caused by manifold, and potentially conflicting, information and directions (NIMS, 2004). As shown in Figure 4, ICS consists of five major functional areas: Command, Planning, Operations, Logistics, and Finance & Administration (NIMS, 2004).

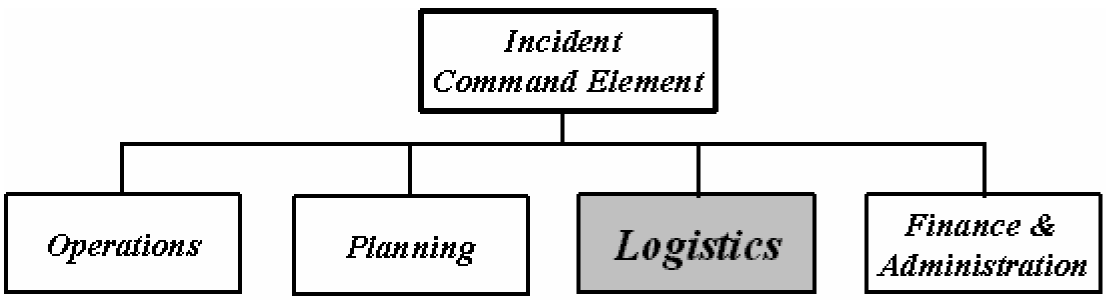

Figure 4. Incident Command Element Hierarchy (NIMS, 2004, p 13)

The NIMS command structure places logistics as one of the core sections within its Incident Command System (ICS). The Logistics Section of the ICS is designed to be flexible in design and function to more effectively and efficiently meet each specific incident's requirements. The ICS command structure calls for an Incident Command Section Chief to determine the initial organizational structure of his or her particular section. The organizational structure is then designed to allow transformation to meet the requirements of the particular incident. ICS's organizational structure is modular by nature, allowing for variations in the size, type, complexity, and scope of an incident (NIMS, 2004).

The implementation of modularity within an organizational framework is based on several considerations. First, the form of the organization must be developed to coincide with its function or task. Second, only the functional elements needed to meet the requirements of the specific function should be staffed. Third, span-of-control guidelines must be observed. This requires a high level of organizational and individual discipline and confidence in the plan and those placed in positions of authority. Fourth, functions of any non-activated organizational element must be performed at the next highest level. And finally, to keep confusion, redundancy, and wasted effort to a minimum, organizational elements that are no longer required must be deactivated (NIMS, 2004).

Although the overall concepts of the NIMS are reasonable and have been successfully employed in the past, the unpredictable and increasingly complex nature of new situations requires innovative solutions. In addition to the right people, the right training, and the right plan, the right technologies also need to be put into action on a practical level.

B. UNITED NATIONS CRISIS RESPONSE MODEL

The United Nations' Office for the Coordination of Humanitarian Affairs (OCHA) is responsible to "mobilize and coordinate effective and principled humanitarian action in partnership with national and international actors in order to: alleviate human suffering in disasters and emergencies; advocate for the rights of people in need; promote preparedness and prevention; and facilitate sustainable solutions." (OCHA, 2005, p 5). For logistics management, OCHA maintains a Logistics Support Unit (LSU). The LSU is a small unit that has a planned staffing of only three personnel and a 2006 requested budget of 443,629 U.S. Dollars (LSU OCHA, 2006).

OCHA's LSU receives primary backing from the United Nations Joint Logistics Center (UNJLC). The UNJLC was formed to provide leadership in assembling and managing humanitarian resources. The UNJLC's formation was motivated by the 1996 crisis in Eastern Zaire where significant problems with resource distribution and cooperation among various agencies became tremendously evident. The UNJLC concept has been effectively used in several UN operations including Somalia, Kosovo, East Timor and Afghanistan. The UNJLC has become more formalized with a permanent standing presence in Rome (UNJLC, 2005).

The UNJLC, initiated in March 2002, supports several UN entities including the United Nations High Commission for Refugees (UNHCR), the United Nations Children's Fund UNICEF, the World Health Organization (WHO), and the World Food Program (WFP). The WFP acts as the UNJLC's custodian, contributing personnel and assets. The UNJLC's core unit is also housed within the WFP's Operations Department (UNJLC, 2005). The core unit provides the base structure to respond to UNJLC operations. The size of a mobilized UNJLC is kept to a minimum to maintain flexibility. After the decision is made to mobilize the UNJLC, support staff requirements are determined. The staffing requirements are then manned to meet the mission's requirement (UNJLC, 2005).

Because of its joint nature, the UNJLC provides a standardized controlling body for the implementation of technologies across the various UN agencies. The need for a centralized logistics coordination center is a common goal of both the United States and the United Nations crisis response bodies. A primary principle to keep in mind is the common evidence of growing modularity within their structures. Figure 5 illustrates the modularity provided by the UNJLC. While these UN agencies possess their own in-house logistics section, they can call upon the UNJLC for technical expertise and material support.

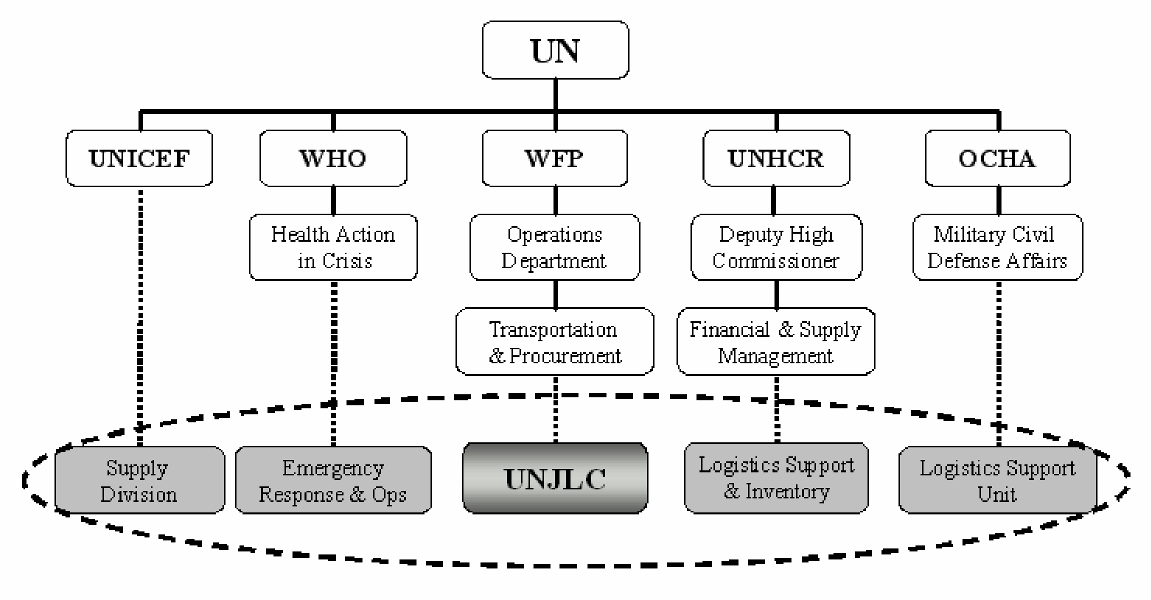

Figure 5. Logistical Modularity in the UN

(for more information on organizational structures and relationships, see OCHA, 2006), UNHCR, 2004, UNICEF, 2006, UNWFP, 2004, UNWHO, 2006)

Achieving redundancy, modularity and a common operational picture through asset visibility are the primary motivating factors in the implementation of technology in support of logistical operations during crisis response. Achieving a common vision across various competing and independent agencies is an enormous undertaking. But, powerful tools do exist and even more compelling ones are being developed. So the question is not can we use these tools, but how to best implement them.

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IV. OVERVIEW OF RELEVANT TECHNOLOGIES

In this section, we look at relevant technologies that are available and in use by the private sector and various government agencies. In doing so, technologies that directly relate to the enhancement of coordinated logistics operations will be highlighted.

A. RADIO FREQUENCY IDENTIFICATION (RFID)

RFID technology is a means of identifying unique objects through the use of radio frequency transmissions. This rapidly growing and proven technology can support asset visibility during crisis management by allowing data to be captured quickly, efficiently and accurately throughout all stages of the supply chain. Access to reliable information regarding the location, quantity, condition and description of resources increases the quality of rational decision-making at all levels of command. The group of technologies that make up radio frequency identification can be broken down into the three general categories of active, semi-passive and passive RFID. The functional components of an RFID tag consist of a chip, antenna, and in some cases a power supply (See Figure 6). The chip holds descriptive information about the item and the antenna is a means of transmitting that information. Table 2 provides an overview of the three types of RFID technologies currently in use with common applications and technical specifications (GAO, 2005).

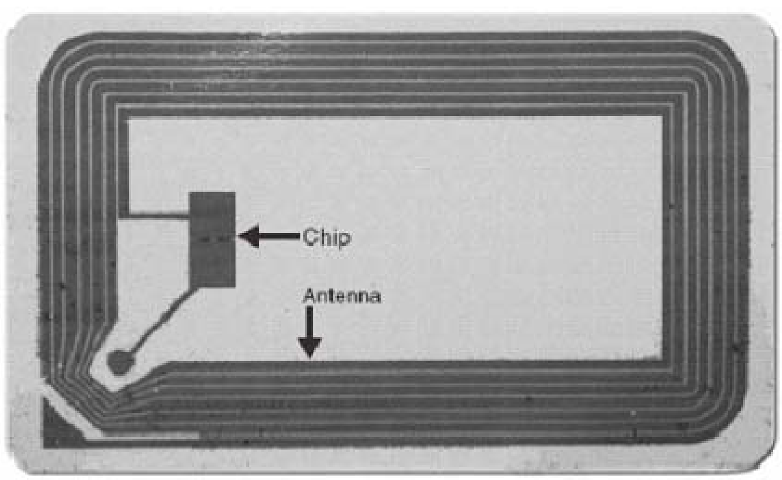

Figure 6. Standard Passive RFID Tag (GAO, 2005)

	Active Tag	Passive Tag	Semi-passive Tag
Power Source	Battery embedded with Tag	Radio waves captured from reader used for both operation and communication	Battery embedded in tag for operation and radio waves captured from reader for communication
Tag Signal Range	Transmits continually or intermittently with ranges reaching several hundred feet	Only available within range of reader	Only available within range of reader
Signal Strength emitted by tag	High	Low	Low
Signal Strength required from Reader	Low to None	High	Low
Typical Applications	Used to track high-value items that are being transported over long distance (i.e. rail cars, container ships)	Used for high volume situations where goods pass through a control point. (i.e. retail check out counters)	Used to track high-value items that are being transported over long distance (i.e. rail cars, container ships)

Table 2. RFID Tags (Meloan, 2003)

1. Passive RFID

In many ways passive RFID is seen as the successor to today's bar code technology. However, passive RFID technology has several advantages over bar code technology. First, passive RFID tags do not require line-of-sight to be read. Also, in many cases, line-of-sight is not required when writing to them. This allows RFID tags to be placed within packaging, thus minimizing the chance of damage or tampering. Second, the read range of most passive RFID tags exceeds that of barcodes. Third, many RFID tags can be read simultaneously. For example, a pallet loaded with RFID tagged boxes of blankets, cartons of diapers, and cases of emergency rations can be carried by forklift through an RFID interrogation station and those particular items can be identified and inventoried without any additional operator interaction. Fourth, RFID tags have the potential to store far more data than standard barcodes. Instead of just identifying a type of product, RFID tags can identify a particular item with its very own identification number.

With more advanced tags a particular item's historical data such as location, temperature and moisture profile can be stored and later read (Wilkas, 2004).

There are also challenges associated with passive RFID technology. In some ways, the technology is still in the developmental stage. As the technology further develops, there is a great need for common standards. The level of success in developing these common standards will have a tremendous impact on the value of RFID systems today and into the future. The two main dynamic drivers involved in developing standards include the continuous advancements in new RFID technologies and the continuous growth in prospective RFID uses throughout the world's supply chain. The ongoing integration of the global economy makes this standardization even more important (GAO, 2005).

EPCglobal is a leading non-profit association working to develop effective standards for RFID and other supply chain tracking protocols. EPC has an open membership founded cooperatively between European Article Numbering International (EAN) and the Uniform Code Council (UCC). Its standard model is based on their vision of providing "a simple, compact license plate that uniquely identifies (items, cases, pallets, locations, etc.) in the supply chain" (EPC Global Inc, 2005) which they have trademarked as the Electronic Product Code™ (EPC). "The EPCglobal Network is a set of technologies that enable immediate, automatic identification and sharing of information on items in the supply chain." (EPC Global Inc, 2005). The EPC itself is comprised of sets of numbers, each with a specific purpose (See Figure 7).

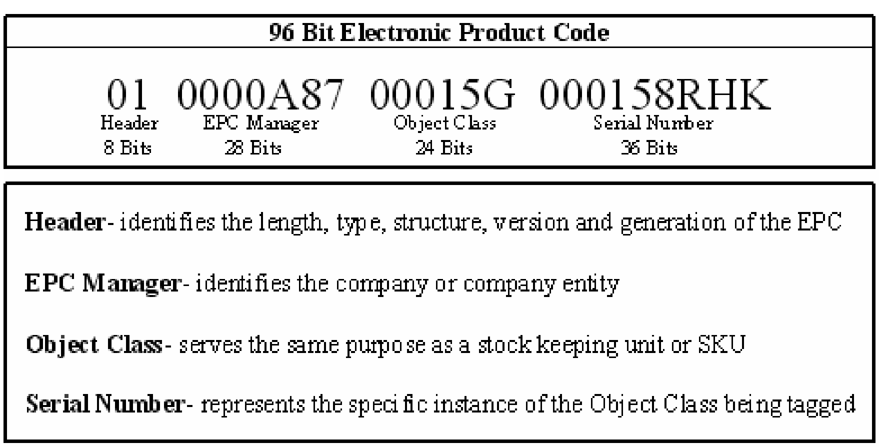

Figure 7. EPC Tag (Meloan, 2003)

Another challenge with passive RFID is the initial startup and recurring operational cost. Initial costs include readers (interrogators), writers, network systems, training and other required material modifications to set up the system. Recurring costs include the cost of the actual tags, equipment upkeep and ongoing training (GAO, 2005).

As the technology has developed, there have been cost reductions due to learning curve and economies of scale. If growth in RFID continues, as many expect, the cost per tag and the associated return on investment will continue to make the implementation of RFID more economically practical (ID Tech Ex, 2005).

More and more companies, including leaders like Wal-Mart™, have begun implementing RFID technology into their logistics system (ID Tech Ex, 2005). The next few years will likely determine whether passive RFID will become a wide spread industry standard like the Uniform Product Code (UPC), remain more of a niche technology, or mature in another direction.

2. Passive RFID Technology Basics

Three primary elements make up passive RFID tags. The *Chip* stores the representative data for the item to which the tag is attached. The *Antenna* receives energy and data signals from an interrogator and can then transmit data from the chip back to the interrogator. The third necessary component of an RFID tag is its *Packaging*. The packaging is used to secure the tag to an item and hold the chip and tag in the proper position (DSCC, 2005).

A common RFID packaging practice is to attach the chip and antenna on a printable integrated barcode providing backward compatibility (See Figure 8). There are also a growing number of dual format reader-interrogators that have the ability to read both RFID and barcode data. This flexibility is vital to many types of operations and can smooth several of the difficulties with any industry in transition from one standard to another. Additionally, the redundancy of dual-technology tags can be of great value. For example, if a tagged label is covered by exterior packaging, the RFID will likely still provide effective identification. If the RFID circuitry is damaged the barcode will most likely still be readable. These types of redundant practices decrease the probability that critical processes will be bypassed if certain aspects of the technology fail (Buy RFID, 2005).

Figure 8. Hand-held Scanner and Passive RFID Tag (PSC, 2006; Microsoft, 2006)

3. Active RFID

Active RFID encompasses a wide variety of technologies and levels of complexity. Active RFID is generally composed of a battery energized tag that generates a relatively strong, constant or intermittent, signal that in many cases reaches 300 feet. Some common types of active RFID tags utilize satellite and cellular telephone based transponders. After an active tag generates a signal, then a portable or stationary receiver collects the tag data and can integrate that data into a designated asset tracking and identification system. One of the main limitations of active, as well as semi-passive, RFID tags is their usual dependence on battery power. As battery life and signal handling efficiency have improved, the effective operational life of active tags has similarly increased (GAO, 2005).

Active tags, in one of their simplest forms, provide serial number type data that can be read either while static or in motion. However, active tags can also be integrated with various sensors so they can store and transmit large amounts of descriptive data and conditional parameters such as temperature, moisture content and impact readings (GAO, 2005).

Active tags are generally more expensive than passive tags and therefore are more frequently used with high value items or larger amounts of particular items. For example, many rail cars are fitted with active RFID for tracking and inventory purposes. Because of greater costs associated with active tags, they are generally configured to be re-used (GAO, 2005).

4. Semi-passive RFID

Semi-passive RFID generally refers to tags that are read by a passive interrogator but also provide additional sensor or specification data. Like active RFID tags, semi-passive tags require batteries. Common sensor parameters include temperature, moisture content and impact readings. Compared with standard passive tags, semi-passive tags provide additional benefits at higher costs (Meloan, 2003).

B. SATELLITES

As we saw during the aftermath of Hurricane Katrina, existing communications infrastructure is vulnerable to destructive forces. Satellite systems offer redundancy and reliability that can circumvent such problems and therefore deserve serious consideration within logistical frameworks. Several different global positioning and communication satellite systems are currently in use or being implemented. Their far-reaching capabilities transcend existing ground-based communication infrastructure.

When satellites were first developed, they had little impact on the average person. Today, they are instrumental to a wide array of military and private sector operations. In addition to delivering television, telephone and radio signals, satellites are used to map the globe. This capability allows users to precisely pinpoint any particular location on the Earth's surface, an invaluable tool for navigational purposes and asset tracking. With the capability to transfer large amounts of data becoming commonplace, satellites are helping to make the idea of a global connectivity possible. Corporations such as Hughes and Motorola are putting satellite systems into space that will supply extensive broadband data capabilities. If everything works as predicted, users of satellite broadband will be able to connect to the internet via satellite from anywhere on earth (Whalen, 2006).

The United States' Global Positioning System (GPS) includes 24 NAVSTAR satellites operated by the U.S. Air Force. It is used to track everything from airplanes, vehicles, ships, and personal electronic devices to people and animals. Common applications include: navigation, construction, farming, mining, logistical supply-chain management, package delivery, geological forecasting, emergency services, and biological research (Pellerin, 2006).

GPS tracking can provide real-time asset visibility anywhere with satellite coverage. A GPS-capable device, affixed to a logistical asset, obtains a triangulated fix by comparing distances from various GPS satellites in orbit. After a fix is obtained, a transponder transfers data via communication satellite to a station that can transmit the location information through various communication systems (Land Air Sea, 2005). GPS satellite tracking can provide a secure and reliable tracking system for use in conjunction with logistical planning in areas that have been subject to various forms of devastation (GPS Select, 2005).

Currently, the United States maintains the only truly global, fully-operational system. However, the European Union and countries including Russia, Japan and China are developing their own international satellite navigation systems. International negotiations ranging from financial partnering to interoperability are issues of great interest to all involved (Pellerin, 2006).

C. RESOURCE DATABASES/APPLICATION SOFTWARE

Technological advances associated with computer hardware have provided organizations the ability to store massive amounts of information relatively cheaply. However, problems associated with information overload can outweigh the potential benefits of collecting data. Application software provides a means to effectively use large amounts of data. Data mining, querying, and the ability to generate ad hoc reports are some of the tools available to users (GAO, 2005).

Private sector companies like WalMart™ have demonstrated the feasibility of implementing IT systems that are capable of effectively managing enormous amounts of data. When the cashier scans an item at checkout, the information is stored in a database where it is immediately accessible throughout the supply chain. The information, recorded one time, is then used for re-stocking, quarterly reports, transportation scheduling, raw material purchases, etc. (ID Tech Ex, 2005). Giving the appropriate people access to the right information increases their ability to make better decisions. It also provides all interested agents the ability to view the same data in real-time.

V. PROPOSED LOGISTICS FRAMEWORK

A. INTEGRATED COMMUNICATIONS NETWORK MODEL

Recalling the conceptual model presented earlier, Figure 9 illustrates how the Logistics Function fits within an overall communications framework.

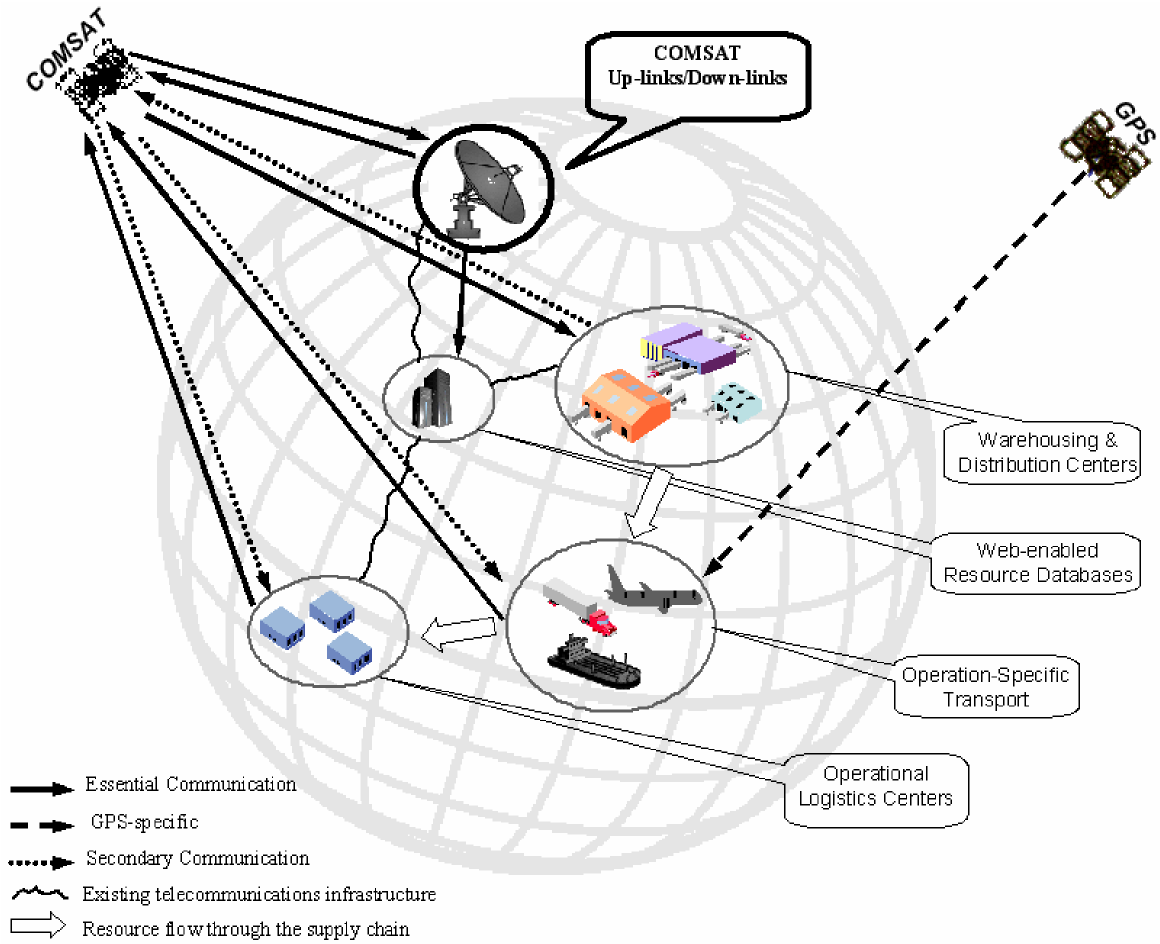

Figure 9. Communications Model (adapted from DSCC, 2005)

Perhaps the most essential characteristic of the proposed framework is that of open architectural design. It can operate in conjunction with various existing telecommunications infrastructures or independent of them. By incorporating resource databases and powerful application software, it can easily accept various technologies that adhere to universal standards and specifications. Further, because current satellite systems are capable of operating with various satellite communication devices, several different methods of data transfer can be utilized. This redundant capability affords alternatives that create a seamless logistics process within the overall framework. More importantly, the framework will facilitate the goal of maintaining a common operational picture among all relevant agents and throughout all levels of the supply chain.

B. INTEGRATED SUPPLY CHAIN MODEL

The proposed logistics supply chain can be broken down into five separate stages or components comprising Manufacturers, Distribution Centers, Carriers, Operational Logistics Centers, and the Customer. The following figure shows how both active and passive RFID technology can be integrated throughout the supply chain.

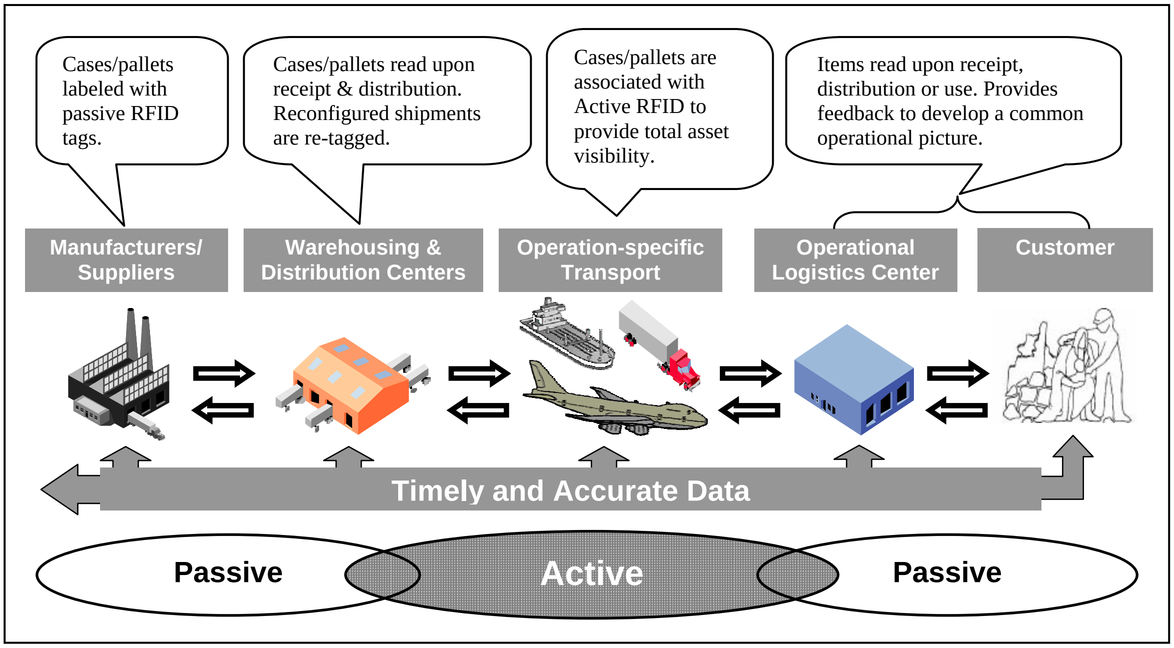

Figure 10. Integrated Supply Chain (adapted from DSCC, 2005)

Active RFID technology, including satellite tracking, is generally most effective in maintaining asset visibility between the Distribution Centers and the Operational Logistics Centers. Passive RFID is better suited for tracking assets between the Suppliers and Distribution Centers. It is also better for interactions involving Operational Logistics Centers and Customers. This can be accomplished by capturing data from passive RFID tags to be included within an electronic manifest that will be associated with a specific active RFID tag. The current supply chain model that is being employed within existing frameworks is similar to that of an integrated military supply system. However, there are some distinct areas where the two vary. In these areas the disaster response logistics system should be better aligned with military protocols as these standards have been designed for and employed in many unforgiving environments. Military and disaster response logistics operations are being transformed through the development of logistics technologies. Applying these technologies appropriately will require flexibility as each incident response will vary according to specific circumstances.

C. TRACKING RESOURCES THROUGH THE SUPPLY CHAIN

1. Manufacturers/Suppliers

The first stage of the integrated supply chain involves the Manufacturers who originally produce and package the required items. These items may or may not be initially or solely produced for crisis response. For example, a plastic tarp manufacturer in Mexico may ship their product to the United States where it could be sold at a Wal-Mart™ or purchased by the government for integration into an emergency response kit. The tracking process begins with the identification of a requirement and the subsequent creation of a requisition within the web-enabled database. Ideally, the Manufacturer will be incorporated into the integrated communications network. This will enable asset visibility beginning at the time of initial shipment.

Preferably, the manufacturer will be responsible for tagging the resource with a passive, EPC-compliant RFID tag that may also be encoded with additional value-added data. Examples of additional data might include instructions for use or relevant warnings. Issues of consideration include tag placement (where on the product the tag should be placed), and what level of identification is practical (every pallet, every case, or every individual unit). Currently, DoD contracting guidelines require RFID compliance from vendors. Specifically, “the “DoD will use and require its suppliers to use EPC Class 0 and Class 1 tags, readers and complimentary devices” (USD AT&L, 2004, p 1). Further, “Radio Frequency Identification will be a mandatory DoD requirement on solicitations issued on or after October 1, 2004 for delivery of material on or after January 1, 2005” (USD AT&L, 2004, p 1).

The process of incorporating tagged items into the crisis response supply chain can be simplified through the utilization of common labeling standards for military, business, and crisis response agencies. Since the DoD has focused much of their efforts on the adoption of industry best practices and standards, it would be most effective to apply those same standards to the procurement of crisis response resources. Aligning procurement standards with the DoD will facilitate further compliance among vendors as it will allow them to identically label items for practically all government agencies. It will also allow military-specific items to be more easily integrated into any crisis response framework. In addition to facilitating integration, standardization enables flexibility, accuracy, and lower costs (USD AT&L, 2004).

Given that this is the initial stage of the supply chain, decisions and actions made at the manufacturer level can greatly affect the success of the rest of the system. Remedial actions, such as retagging, can and sometimes will need to be performed at subsequent stages. However, these later actions increase the cost and the probability of introduced errors.

2. Warehousing and Distribution Centers

The second stage of the integrated supply chain involves regional Warehousing and Distribution Centers. This stage covers a wide range of storage and distribution functions and facilities. It includes various commercial distribution centers, long-term emergency supply warehouses, and cross-docking operations. This is the stage where the commercial market most directly interfaces with the crisis response logistical network. RFID technology, utilizing uniform standards, can provide value to crisis response agencies and their suppliers. At these locations, cases, pallets, and containers may be stored, re-packaged or reconfigured to meet operational or emergency reserve requirements.

Once a resource arrives at a Warehouse/Distribution Center, it must pass through a RFID interrogator (static or hand-held) before it can be included as inventory. Maintaining strict discipline at an entry and exit control point is a key factor in ensuring inventory accuracy. The interrogator records all relevant data which is then automatically transferred to the Web-enabled Resource Database via the existing telecommunications infrastructure or via communication satellites. At this point, the increased inventory level associated with this particular resource is immediately reflected within the database. Anyone with access to the database now has visibility of the resource. When the resource leaves a Warehouse/Distribution Center for transport to an Operational Logistics Center, the resource is read by a RFID interrogator. All relevant information related to the in-transit resource is recorded and immediately uploaded to the Web-enabled Database. The decreased inventory level (as well as the fact that the resource is in-transit) is reflected and could trigger a decision to replenish supplies at a particular location.

Consolidated mission packs are one way to achieve additional efficiency and flexibility. This involves reading in data from multiple items tagged with barcodes, RFID tags, or other labeling, then consolidating those items into one package, case, or pallet, and finally re-writing the consolidated information to a single RFID tag. In most cases this process will be completed in preparation for possible future crisis requirements. However, with the integration of RFID, consolidating crisis specific mission packs can be conducted much more effectively during the crisis response.

3. Operation-specific Transport

The third stage in the integrated supply chain involves Operation-specific Transport. This component encompasses movement from warehouse and distribution centers to the in-theater depots and operational logistics centers. This transportation piece covers a wide range of possible modes and distances. It could represent multi-modal intercontinental transport utilizing any combination of ship, rail, truck, and air. It could also represent a mule train moving supplies from warehouses located in the cities of Kashmir to Operational Logistics Centers serving earthquake victims in the surrounding mountain regions.

Asset visibility in this stage could be achieved by utilizing stationary readers, active RFID tags, and existing ground-based communications infrastructure. However, in many relevant crisis scenarios, terrestrial data connectivity may be lost. Satellite communication is much less susceptible to destructive forces that are often common to crisis situations. Satellite technology can bypass infrastructure and communicate directly with logistics assets and secure resource database locations. Asset identification and item specific details can be stored and transmitted from the conveyance or the transport module. The load manifest can be located locally on the conveyance or held remotely at a secure Web-enabled Database site.

While in transit, the satellite transponder, which is attached to a logistics asset, such as a container on a truck, ship, train or plane, periodically receives location data from GPS satellites. It then relays that data to the Web-enabled Database via communication satellites. The resource can be tracked by association with the satellite transponder. If the transponder should fail, the operator of the logistics asset may have the capability of communicating with the command center or directly with the Web-enabled Resource Database using a satellite-enabled phone or computer.

The U.S. Army has had great success with its Movement Tracking System (MTS) (O'Brien, 2004). The system is being tactically employed in Iraq and Afghanistan. MTS uses GPS and communication satellites to track the location of mobile logistics assets. Comtech Mobile Datacom (the company who developed the system) also incorporated two-way satellite text messaging, a capability useful for re-routing instructions, weather conditions, and other real-time situational data. The requirement for MTS grew out of lessons learned from the first Gulf War, where the U.S. Army experienced insufficient asset visibility with respect to logistics assets and resources (Buxbaum, 2005).

An important evolutionary step for MTS is the Military's plan to integrate passive and active RFID technologies into the system. The Department of Defense is in the midst of a massive program to have suppliers place RFID tags on cases and pallets of goods, with the purpose of tracking supplies throughout the supply chain. By incorporating RFID data into MTS, a military logistician will be able to immediately know the location of a vehicle or container as well as its contents. While nearly all of the National Guard's logistics vehicles operating in Iraq are fitted with MTS, relatively none of its U.S.-based vehicles are MTS equipped (Buxbaum, 2005).

4. Operational Logistics Centers

The fourth stage of the integrated supply chain is comprised of Operational Logistics Centers. While these centers perform many of the same functions as the warehouses and distribution centers of the second stage, they differ in that they are located near or at the disaster site. Here, resources are received from operation-specific carriers and subsequently distributed to customers. The Operational Logistics Centers can vary in size and composition depending on the customer base and the supplies received for distribution. Due to challenges associated with connectivity and power during a crisis, this stage can present great difficulties in implementing RFID tracking. However, it is also where the greatest benefits of achieving asset visibility can be realized.

Upon arrival at the Operational Logistics Center, a resource must be read by a RFID interrogator (static or hand-held). All relevant data are then uploaded to, and reflected in, the Web-enabled Database via existing terrestrial telecommunications infrastructure or via the communication satellites. Anyone with access to the database has visibility of the resource. Before being distributed to the end user, resources are read into the database where they are reflected as expended items. Figure 11 illustrates an Operational Logistics Center layout and one possible RFID interrogation configuration.

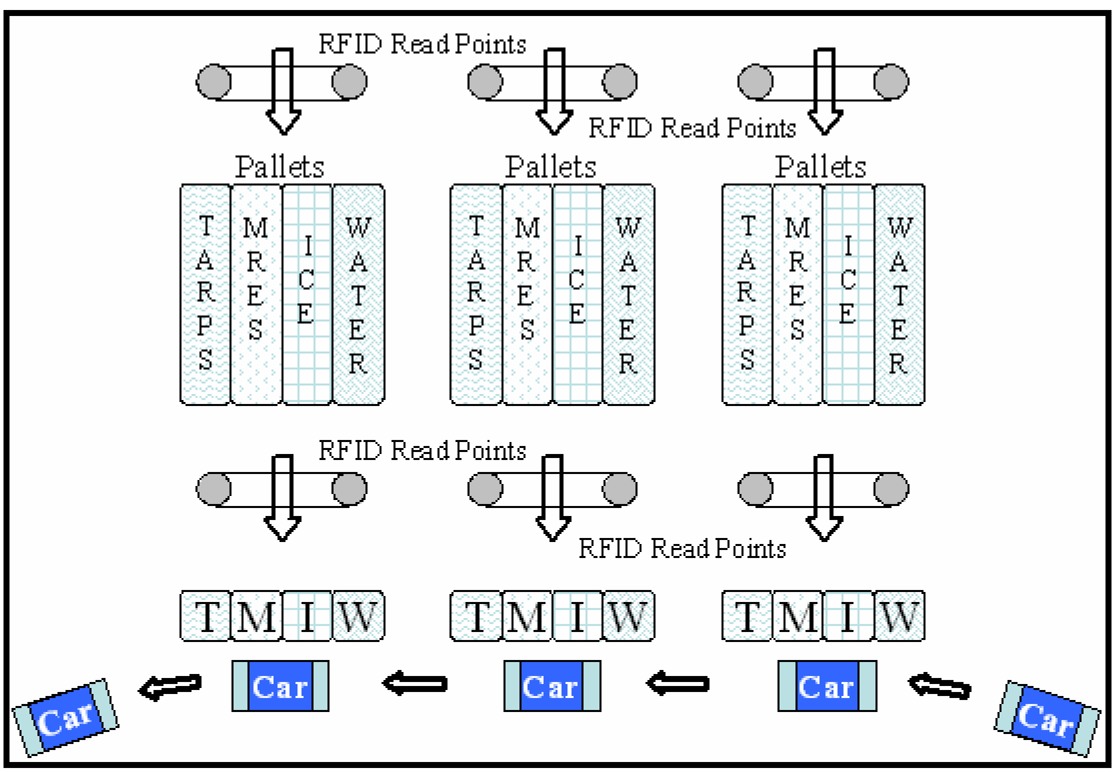

Figure 11. **Operational Logistics Center** (adapted from Randon, 2005)

Using this configuration, the data associated with incoming and outgoing resources can be captured by various forms of RFID readers to include: vehicle-mounted, fork-lift mounted, hand-held and static. Maintaining strict control at the RFID read points will ensure the highest level of data integrity, a factor that is essential for useful Automated Information Systems and other Decision Support Systems.

5. Customers

The customer is the fifth and final stage in the integrated supply chain. Customer is a general term to indicate the point at which the supplies leave the control of the distribution entity. A customer can be a single person in a car, a family on foot or a church bus obtaining supplies for victims using a church as a refuge center.

The ultimate goal of the supply chain is to provide support to these end users. The ability to tie materials expended to particular end users can provide valuable data to the tracking and distribution system. This data can be used to calculate current or estimate future requirements such as food, transportation, lodging and medical supplies. However, due to the challenges associated with providing aid to distressed refugees, collecting customer data can be challenging. These challenges could be overcome through the use of personal RFID cards, bracelets, or other wearable devices (Gao, 2004).

Overall, the key to effective utilization of any technology during crisis response is the ability to trace the benefits of the technology directly to the customers. Even if the technology provides reliable total asset visibility throughout the integrated supply chain, if it does not improve the lot of the customer, it is basically unjustifiable. Having access to the information is the easy part. Being able to effectively interpret that information and achieve a useful common operational picture will require skill and training. By maximizing the efficiency with which resources are allocated and distributed, planners and managers can deliver the best possible relief or service to end users.

VI. CONCLUSIONS

Maintaining a state of readiness for unexpected events is a complicated undertaking that requires more than simply publishing a set of policies and procedures. Instead, it will take a sustained, long-term commitment from capable leaders and trained personnel to do what is necessary for the successful implementation of a viable logistics framework. In addition to the three critical success factors introduced in Figure 1, modularity, integrated systems, and asset visibility technology, we will address considerations for training and procurement.

Achieving modularity with respect to structure, resource configuration and systems will require that the right people be appointed to key positions, people that understand coordinated logistics and the complexities that accompany it. The U.S. Federal government has acknowledged the need to fully integrate the DoD into the National Response Plan (NRP). They emphasize integration at every level of government (The White House, 2006). This acknowledgement could turn out to be the most critical element toward a successful strategic shift in the way crisis management activities are conducted. Properly incorporated into the NRP, certain U.S. DoD logistics systems and practices currently in use would offer numerous benefits (Learning curve, turn-key operational abilities, and cost). The salaries of DoD personnel are in essence a fixed cost. Units already exist whose missions can be modified to include crisis response as a core competency. Assigning a primary role to the DoD exploits a highly-trained, in-place personnel structure.

The overall manner in which the U.S. military trains and organizes its operations serves as one of the best models for use during crisis management activities. This is mainly due to the culture of discipline that exists within the military and the experience it has in conducting operations during chaos and war. National Guard and component reserve units are best suited to train for rapid response within each of the Department of Homeland Security's 10 designated crisis response regions. They are well-suited to run Operational Logistics Centers, and their military bearing and presence will increase the likelihood of order during a crisis. They possess the necessary discipline, basic skills, esprit de corps, and training opportunities. Any attempt to create this core capability from scratch would face myriad challenges that have already been met by the National Guard.

In order to implement an effective training program, designated agencies and military units will need to become intimate with procedures and systems. Federal and State governments need to consider long-term budget implications in at least two main areas: (1) The procurement of commercial off the shelf (COTS) items and (2) The quarterly training of designated national guardsmen, reservists, and emergency operation center (EOC) personnel. Table 3 provides some general estimates of critical items and resources as well as training requirements based on populations within the 10 Federal Emergency Management Regions. Assumptions used in calculating the estimates follow; population estimates are taken from the U.S. Census Bureau (2005).

DHS Regions	Population per Region	Operational Logistics Centers per Region	Requirement for Satellite Transponders (Active RFID)	Requirement for Static RFID Readers	Requirement for hand-held RFID Readers	Quartery training for EOC Personnel
I	20,000,000	100	5,000	400	1,000	2,400
II	29,000,000	145	7,250	580	1,450	3,480
III	30,000,000	150	7,500	600	1,500	3,600
IV	52,000,000	260	13,000	1,040	2,600	6,240
V	51,000,000	255	12,750	1,020	2,550	6,120
VI	35,000,000	175	8,750	700	1,750	4,200
VII	14,000,000	70	3,500	280	700	1,680
VIII	10,000,000	50	2,500	200	500	1,200
IX	45,000,000	225	11,250	900	2,250	5,400
X	6,000,000	30	1,500	120	300	720
Totals	**292,000,000**	**1,460**	***73,000***	***5,840***	***14,600***	**35,040**

Table 3. Procurement Considerations

Transponder Assumptions for Table 3

1) Estimates are based on the assumption that no more than 25% of a particular Region is affected.

2) One Module consists of 5 containers loaded with enough life-sustaining resources for 5,000 people per day.

3) When more than 25% of a particular region is affected, containers will be involved in multiple trips per day to Logistics Operations Centers either within their Region or within neighboring Regions.

RFID Reader Assumptions for Table 3

1) The above estimates are based on the assumption that no more than 10% of a particular region is affected.

2) One Logistics Operations Center can service up to 20,000 people/day.

3) In the case where more than 10% of a particular region is affected, assume that Logistics Operations Center assets will be pulled from neighboring Regions.

4) Assume 10 hand-held Interrogators per Logistics Operations Center.

5) Assume 6 Static Interrogators per Logistics Operations Center.

Training Assumptions for Table 3

1) Assume 24 National Guardsmen, Reservists, and other State EOC Personnel are needed to operate one Logistics Operations Center.

2) The above estimates are based on the assumption that no more than 10% of a particular region is affected.

3) One Logistics Operations Center can service up to 20,000 people/day.

4) In the case where more than 10% of a particular region is affected, assume that Logistics Operations Center assets, to include personnel, will be pulled from neighboring Regions.

Commercial off-the-shelf products exist that can be utilized to create a framework that integrates all necessary elements of an effective crisis response logistics system for use by the DoD, DHS, the private sector, and the international community. The U.S. Military and private sector companies are currently employing effective comprehensive asset-tracking technologies. As we discussed in the previous section, the U.S. Army has had great success with MTS. Wal-Mart™ is an industry pioneer and leader with respect to supply chain management. Adopting these and other industry best practices into an integrated, comprehensive and standardized framework offers proven benefits. In addition to maximizing efficiency with respect to resource allocation and distribution, more information will be available to decision makers. But, unless leaders dedicate adequate attention and effort to sustained training and funding, even the best plan will be impaired.

The next major crisis is coming. It could be a storm, a pandemic, an earthquake, a tsunami or an attack involving weapons of mass destruction. With any of these real possibilities, a swift and effective logistics response can be greatly enhanced by achieving higher levels of asset visibility. To improve asset visibility and promote a common operational picture, organizational command & control structures and physical resource flows must be tied together through timely and accurate information stored and shared via an integrated communications network. The logistics component of the crisis response framework must be flexible and modular enough to be task organized to meet the challenges associated with incidents of varying scope and complexity. Several technologies presented here have greatly enhanced the ability to gain a common operational picture. As these technologies mature and new technologies become available, the primary question should always be how it will affect customers. In this case, the customers are the victims whose lives and property will be at stake. Creation of a common operational picture using a modular, flexible, and integrated logistics system can dramatically increase the likelihood of a successful response effort. The time for action is now, before the next major crisis is upon us.

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