Study:

PUBLIC SERVICES | GLOBAL TRADE MANAGEMENT PRACTICE

ASIA-PACIFIC ECONOMIC COOPERATION

STAR-BEST PROJECT COST-BENEFIT ANALYSIS

NOVEMBER 2003

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Asia-Pacific Economic Cooperation
STAR-BEST Project Cost-Benefit Analysis

IN THIS STUDY:

The first Secure Trade in the APEC Region (STAR) initiative, Bangkok/Laem Chabang Efficient and Secure Trade (STAR-BEST), was a pilot project to test concepts and technologies for implementing an end-to-end supply chain security system. APEC, the Asia-Pacific Economic Cooperation, commissioned BearingPoint to study the financial impact of STAR-BEST through a detailed cost-benefit analysis. The STAR-BEST project tested the technical and financial feasibility of establishing a secure supply chain between Thailand and the United States. A net positive analysis would highlight the financial benefits of a secure supply chain both to shippers and customers, helping pave the way for rapid deployment of the project model by security service providers.

STAR-BEST implemented an end-to-end supply chain solution using radio frequency identification (RFID) technology and electronic seals to track secure containers from points of origin in Thailand to distribution centers in Seattle, Washington. Using the data from this demonstration project and similar initiatives, BearingPoint initiated a cost benefit analysis and completed a detailed study. The executive summary of that report is provided here. If you would like to receive the complete report, please contact us at +1.866.BRNGPNT or visit our website at www.bearingpoint.com.

Executive Summary

A. Purpose, Background and Objectives

Asia-Pacific Economic Cooperation (APEC) made a commitment during the organization's annual meeting in 2002 to improve trans-Pacific trade security. Building on this commitment, APEC held a conference in February 2003 focused on Secure Trade in the APEC Region (STAR) and pledged to develop a pilot project to test concepts and technologies for implementing an end-to-end supply chain security system. From this conference emerged the STAR Bangkok Laem Chabang Efficient and Secure Trade (STAR-BEST) Project. The goal of the APEC STAR-BEST Project is to strengthen U.S.-Thai economic relationships, facilitate international trade, enhance Thai trade competitiveness, increase business confidence in trans-Pacific trade lanes, and deter terrorist attacks that could adversely impact global commerce.

The STAR-BEST Project tested a secure end-to-end supply chain between the ports of Laem Chabang, Thailand and Seattle, Washington. The effort involved the establishment of security protocols and business procedures and the installation of a supply chain security and tracking solution, as well as capacity building efforts to train shippers, port operators and public officials in the new systems and procedures. The STAR-BEST Project aimed to measure the technical feasibility of establishing a secure supply chain and to evaluate the financial feasibility of such a solution. Therefore, a cost-benefit analysis was commissioned to study the pilot project. The cost-benefit analysis has three objectives:

- To understand the supply chain business processes of the APEC-BEST participants.
- To use this understanding of business processes to provide an aggregate high-level appraisal of the solution costs and benefits for both commercial and government stakeholders.
- To support the cost-benefit conclusions with empirical data from the demonstrations where possible.

This paper attempts to meet these objectives and give readers a broad understanding of the solution and the associated financial ramifications.

B. Business Model and Assumptions

To simplify the understanding of the potential benefits of such a solution, the financial modeling of the cost-benefit analysis is based on a "service provider" business model. While multiplate operating structures are conceivable, the business model used for this analysis has single entity designs, deploys and operates the required infrastructure and networked information systems. This service provider, in turn, charges shippers a per container fee to utilize the network. The cost-benefit analysis works on three levels:

- First, the cost to the service provider to establish and maintain the network must be balanced against the benefits the service provider accrues through per container revenue.
- Second, the costs per container that a shipper will pay must be balanced against the benefits realized through greater supply chain security and efficiency.
- Third, the public, particularly the American public, will accrue some benefit from the system in terms of increased security and a lower probability of a terror attack utilizing shipping containers.

The model assumes that shippers will accrue benefits in six critical areas:

- Lower Customs Service inspection rates.
- Reduced safety stocks.
- Reduced bill of lading (BOL) surcharges.
- Reduced pilferage incidents.
- Reduced insurance costs.
- Reduced container-tracking costs.

These assumptions were tested using risk analysis software and a Monte Carlo sampling methodology to ascertain the range and statistical distribution of possible results.

C. Findings

The end-to-end supply chain security solution provided by Savi Technology and tested by the STAR-BEST Project is financially feasible. Companies importing goods into the United States should realize impressive financial benefits by utilizing this technology to secure, track and manage their supply chains. These benefits are as follows:

- Visibility improvement from better predictability and timeliness of cargo shipments.
- Cost avoidance related to emerging U.S. Customs' trade security measures.
- Reductions in safety stock and inventory carrying costs from improvements in trade compliance and in-transit visibility.
- Customer service improvement to sales channels and resellers.
- Profit increases from improved product in-stock rates.
- Reductions in incidences and direct costs of theft and pilferage.

The majority of these result from greater supply chain visibility and transparency and process improvements that will allow importers to reduce transit time variations and inventory safety stocks. A quantitative summary of per container benefits to a shipper and a solution provider are as follows:

- Aggregate benefits range anywhere from $150-$2000 per container.
- Adjusted conservatively for uncertainty and risk, there is an 80 percent probability that benefits will exceed $220 per container.
- The breakeven volume for a service provider charging $220 per container would be appro-proximately 8,000 containers per year. A service provider who deploys a working solution based on this technology should be able to recoup its cost and earn healthy returns.

While the benefits from increased supply chain efficiencies make the deployment of this solution advantageous to importers in the United States, the benefits the solution provides to transportation security are difficult to measure. Other supply chain security initiatives currently underway are studying the vulnerability reductions to be expected in deployment of this technology, and it is expected that they will provide additional information to quantitatively assess these security improvements.

D. Recommendations for Future Analysis

This study is far from a complete and definitive analysis of all the costs and benefits that will accompany a full implementation of the solution. Given additional time and funding, a more thorough analysis of implementation costs and resulting benefits would be possible. Additional resources would allow for more rigorous testing of the assumptions used in this analysis and a broader understanding of the solution's potential to improve both business operations and security. Additionally, the financial model could be extended to support the analysis of multiple ports of origin and destination to quantitatively assess the impact of the network effect as described in Section 2.C.

I. Program Overview

A. Purpose/Background

Following the attacks on the World Trade Center and the Pentagon on September 11, 2001, the world's attention turned to the threat that international terrorism posed to the political stability and economic interconnections upon which international trade relied. Increasingly, security experts have focused on the rapidly growing and highly vulnerable movement of marine shipping containers. Estimates place the number of containers in circulation at approximately 15 million.[1] These containers were moved through ports approximately 232 million times in 2001.[2] The anthrax attacks in the United States in the fall of 2001, continued unease regarding nuclear weapon development in North Korea, Iraq and Iran, and an increased respect for the sophistication of Al Qaeda have raised concerns about the potential danger posed by the arrival of shipping containers into large, busy ports without any reliable information on what lies inside.

These concerns seem to have been validated by a disturbing incident in the Italian city of Gioia Tauro in October 2001. As described in the September 2003 issue of *The Atlantic Monthly* magazine[3], port police found an…

"Egyptian-born Canadian citizen named Amid Farid Rizk inside a Maersk Sealand container…His box had been loaded in Port Said, Egypt, and was being transferred in Italy to a ship bound for Rotterdam, where it was scheduled to be transferred again, this time for the final destination of Halifax, Nova Scotia. It is said that Rizk was discovered when the Italian police heard him drilling additional ventilation holes…When he emerged, he was clean-shaven, neatly dressed, and obviously well rested. The container was equipped with a bed, a toilet, a heater, a water supply, a cell phone, a satellite phone, and a laptop computer. Investigators also found cameras; a valid Canadian passport; maps and security passes for airports in Canada, Thailand, and Egypt; a Canadian aircraft-mechanic certificate; and an airline ticket from Montreal to Cairo."

Rizk was subsequently released on bail and disappeared. While human smuggling is not an uncommon use of shipping containers, this case demonstrated the potential threat to international security inherent to a system that facilitates the movement of illicit cargo between countries and continents.

In response to these growing concerns, Asia-Pacific Economic Cooperation (APEC) made a commitment during the organization's annual meeting in 2002 to improve trans-Pacific trade security. Building on this commitment, APEC held a conference in February 2003 focused on Secure Trade in the APEC Region (STAR) and pledged to develop a pilot project in order to test concepts and technologies for implementing an end-to-end supply chain security system. From this conference emerged the STAR Bangkok Laem Chabang Efficient and Secure Trade (STAR-BEST) Project. The goal of the APEC STAR-BEST Project is to strengthen U.S.-Thai economic relationships, facilitate international trade, enhance Thai trade competitiveness, increase business confidence in trans-Pacific shipping routes, and deter terrorist attacks.

The STAR-BEST Project tested a secure end-to-end supply chain between the ports of Laem Chabang, Thailand and Seattle, Washington. The effort involved the establishment of security protocols and business procedures and the installation of a supply chain security and tracking solution, as well as capacity building efforts to train shippers, port operators and the public officials in the new systems and procedures.

The STAR-BEST Project aimed to test the technical feasibility of establishing a secure supply chain and to evaluate the financial feasibility of such a solution. Therefore, a cost-benefit analysis was commissioned to study the pilot project. The cost-benefit analysis has three objectives:

- To understand the supply chain business processes of the APEC-BEST participants.
- To use this understanding of business processes to provide an aggregate high-level cost-benefit of the solution for both commercial and government stakeholders.
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B. Laem Chabang—Seattle Trade Lane

The Laem Chabang to Seattle trade lane serves a variety of companies involved in the trade of goods between Thailand and the United States. Laem Chabang is the primary international port in Thailand. Located southeast of Bangkok along the Gulf of Thailand, Laem Chabang handles roughly 3 million outgoing containers per year; approximately 20 percent (600,000) are exported to the United States.[4] The trade lane includes containers shipped directly to Seattle from Thailand and containers that are shipped to other ports in Asia and transferred to ships bound for Seattle. Common transshipment points include Singapore, Taiwan and Japan.

The Port of Seattle, in the state of Washington, is one of the largest container ports on the West Coast of the United States. It processes 550,000 imported containers per year. Approximately 20,000 originate in Laem Chabang.[5] In 2001, Thailand was the port's eighth-largest trading partner on a dollar value basis. More than 65 percent of the imports and exports that move through the port originate or are destined for Japan and China. Ranked by dollar value, clothing is the number one import into the United States through the Port of Seattle. Other large volume imports include office machines and parts, motor vehicle parts, footwear, and electronic equipment.

C. Project Description and Process Map

Savi Technology assessed the trade lane and implemented an end-to-end supply chain solution aimed at using radio frequency identification (RFID) technology to track secure containers from points of origin—primarily manufacturing and processing facilities—to distribution centers in the United States. From a security standpoint, the solution should increase confidence in the validity of manifests, ensure compliance with U.S. Customs regulations requiring advanced manifest information, decrease the risk associated with adding contents to a container during its shipment, and allow customs officials to utilize limited inspection capabilities more efficiently on containers that pose greater risks. In addition to increased security, financial benefits could accrue to shippers by increasing supply chain visibility and reducing container inspection rates at the terminal. This solution could allow a shipper to lower expenses by lowering logistics and inventory costs and/or increase revenues by improving service rates.

The foundation of the network solution implemented by Savi Technology is an active RFID tag that has been designed to fit on an ISO-standard bolt. The RFID tag is activated when a container is stuffed and sealed at an exporter's facility. As the container moves through the supply chain, the tag broadcasts the container's status and location to a series of readers and signposts positioned at key checkpoints. The RFID tag will notify the system immediately if the electronic seal is broken or removed. The container's status is updated in "real time" onto a secure database where an authorized party can access the data. Not only does this system give security officials more confidence in the reliability of a container's manifest, it also allows shippers to identify inefficiency in the supply chain and pass along order status to customers in the United States.

In Thailand, the pilot project involved 30 containers originating from three separate exporters (see Participants below). Each container was stuffed, sealed and RFID-tagged at the manufacturing/processing/consolidation point, and each tag was programmed with shipment specific information via a handheld reader provided by Savi. Containers were then moved by truck to the Inland Container Depot (ICD) located just south of Bangkok. Savi had installed two signposts and one reader to track each container's arrival, handling and departure. At the ICD, the containers were taken off the trucks and loaded onto rail cars. From there, the containers were shipped south to the Laem Chabang Port. At the port, each container was reloaded on a truck, moved through a port gate and delivered to the appropriate terminal. Savi had installed a reader at a port gate and a reader at one of the port's terminals.

The containers were loaded onto vessels at the terminals and shipped to Seattle. A reader at the receiving terminal recorded each container's arrival in Seattle, and another reader at the port gate recorded each container's departure. All 30 containers that were shipped reached their destination. Every reader and signpost in position to record the containers' movements successfully read the location and status of the containers via the RFID network. See Figure 1.C.1 for a process diagram.

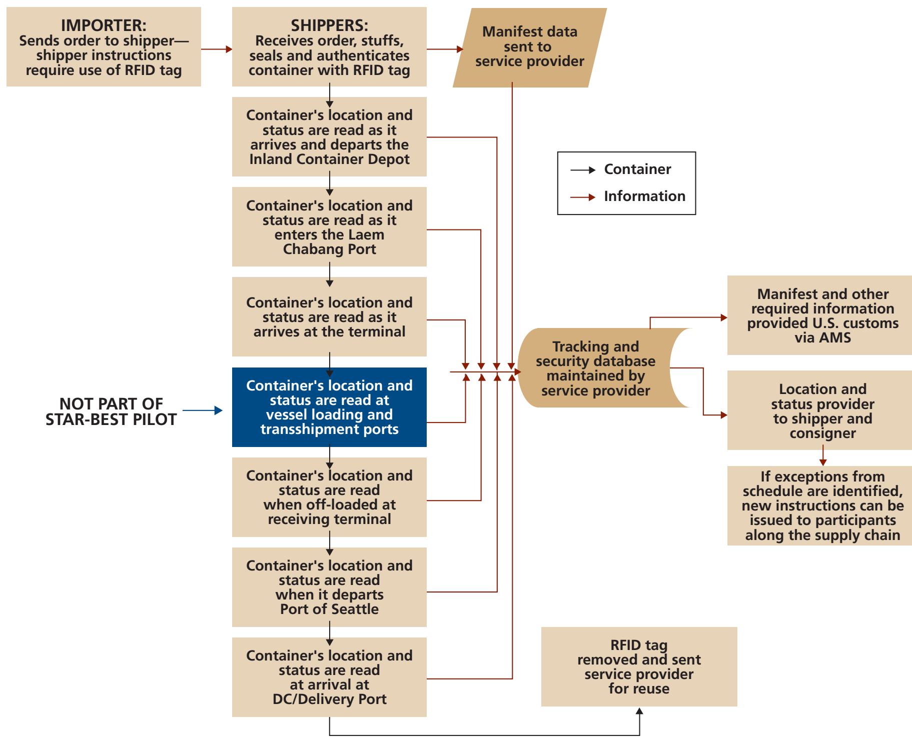
The trial demonstrated that the technology and business processes work. The only problems that occurred were related to the artificiality of the trial, not to any problem with the technology. The primary problem was an insufficient number of readers and signposts. The shortage of hardware was caused by a last minute change in participating shippers. The network technology was deployed along the staging route that the original participant would have used, but the replacement shippers used different terminals at the ICD and the Laem Chabang Port. Only one terminal at the ICD was equipped with Savi's network technology, while most of the containers moved through a different terminal. Containers had to be moved between terminals to ensure that the signposts and readers recorded their position. Similarly, at the port, only one terminal was equipped with a reader, but the majority of containers were moved through a different terminal. In this case, the last recorded container position in Thailand was at the port gate.

D. Participants

Shippers. The exporting companies that agreed to participate in these trials included a tuna processor, a large consumer electronics company and a freight consolidator.

Unicord PLC exports tuna through the Laem Chabang Port to customers around the world.[6] The

FIGURE 1.C.1.
STAR-BEST PROCESS MAP



company ships more than 200 containers a month. Approximately 30 percent are bound for the United States. The company ships both canned tuna in standard containers and frozen tuna in refrigerated containers. The company shipped only one of the 30 containers in the trial.

Thomson Multimedia Thailand manufactures consumer electronics in Thailand and exports them to a variety of markets, including the United States. Thomson shipped 16 containers as part of the STAR-BEST Project.

Expeditors is a third-party logistics provider and freight consolidator. It exports products from Thailand for a number of companies whose operations in Thailand are not sufficiently large or sophisticated to handle the export process on their own. Expeditors shipped 13 containers during the trial.

Thai Terminal Operators. One terminal operator at the ICD and one terminal operator at the Laem Chabang Port were full participants in the STAR-BEST Project. Additionally, other terminals at both the ICD and at the port provided critical assistance.

The Thailand International Freight Forwarders Association (TIFFA) played a critical role in ensuring the project's success. TIFFA operates Terminal T4 at the ICD, and the company agreed to have Savi equipment installed on its premises. Savi installed one reader and two signposts at the terminal to record the arrival and departure of containers from the ICD. Anusorn Lovichit, managing director of TIFFA-Electronic Data Interchange, served as an intermediary between Savi Technology and the other Thailand-based stakeholders. He tracked the project's process, helped resolve issues as they appeared, and served as a subject matter expert to a number of parties. Additionally, he arranged many of the interviews in Thailand that made this cost-benefit analysis possible.

Hanjin Logistics operates Terminal T5 at the ICD. Although it was not an active participant in the STAR-BEST Project, Hanjin provided critical assistance. All but one of the containers shipped through the ICD were routed through Hanjin's terminal instead of TIFFA's terminal. In order to ensure that the Savi equipment performed as expected, Hanjin agreed to let the containers make a trip through TIFFA's area to ensure the containers' presence at the ICD was documented.

The Laem Chabang International Terminal Co., Ltd. (LCIT) at the Laem Chabang Port is a joint venture between P&O Nedlloyd and a Thai company.[7] It operates Terminal B5 and ships approximately 850,000 containers per year from Thailand. LCIT believes that at least 20-30 percent of the containers go directly to the United States. It is unsure of the number of containers shipped to other Asian ports that are eventually transshipped and moved to the United States. LCIT agreed to allow Savi to install one reader at the terminal's entrance. However, only one of the 30 containers actually flowed through Terminal B5.

The Evergreen Container Terminal (Thailand) Ltd. operates Terminal B2 at the Laem Chabang Port.[8] As with Hanjin, Evergreen was not an original participant in the trial. However, most of the containers involved in the STAR-BEST Project were routed through the Evergreen Terminal. While Evergreen was not able to move the containers close to a reader, Evergreen did not object to the RFID-tagged containers moving through its terminal and agreed to speak with other STAR-BEST participants and evaluators about processes and the potential for broader implementation.

Thai Government Offices. The Royal Thai government worked with the United States to facilitate the STAR-BEST Project's development. The project also relied on support from the Port Authority of Thailand and the Laem Chabang Port Customs Authority.

The Port Authority of Thailand operates the Laem Chabang Port and the Bangkok Port. At Laem Chabang, it fully supported the project and allowed Savi Technology to install a reader on the port's C3 gate. All 30 containers equipped with RFID tags were transported through the right gate, and each tag successfully broadcast its location and status to the reader.

The Thai Customs Authority fully supported the STAR-BEST Project.[9] While the authority's active participation was not required, the success of STAR-BEST could impact the authority's processes and its relationship with U.S. Customs.

Port of Seattle. The Port of Seattle operates Seattle's commercial seaport and the Seattle-Tacoma International Airport. The port aims to stimulate business activity to create long-term benefits for the Puget Sound region. More than 500,000 Twenty-foot Equivalent Units are imported through the port each year. Approximately 20,000 arrive from Thailand. Additionally, the Port of Seattle operates as a municipal corporation and reports to King County. As such, it is responsible for King County citizens' security.

The port has been a driving force behind the APEC STAR-BEST Project. It has fully backed the deployment of the technology, worked proactively with the other stakeholders in both the United States and Thailand, and drawn the public's attention to the project.

U.S. Customs.[10] The U.S. Customs Service is supportive of efforts of the STAR-BEST Project, but the agency is not participating in the trial. Among its numerous duties, the Customs Service is responsible for inspecting goods entering the Port of Seattle. Additionally, under the auspices of the Container Security Initiative (CSI), the Customs Service will soon be capable of inspecting U.S.-bound containers before they leave the Laem Chabang Port. The service has the capability to inspect only a small percentage of the containers bound for U.S. ports. It utilizes the Automated Targeting System (ATS) to select containers for inspection. The higher the risk posed by a U.S.-bound container, the greater the probability that the container will be inspected. The assessed risk is reduced as supply chain security levels are improved.

Currently, customs inspects between 2 percent and 4 percent of the containers that enter U.S. ports. Customs aims to increase these rates as more funding for customs field inspectors becomes available. The resulting increase, while improving security, could impose additional costs on importers. In Seattle, customs conducts most container inspections in the terminal. Containers are placed in a "hold" status until inspectors clear them. Customs generally "holds" containers for only a few hours. A small number of inspected containers (approximately 5 percent) are not cleared and moved to an off-site inspection area for a more detailed review. In such cases, containers can be delayed for days. Customs' goal, however, is to release containers on the same day they arrive. The terminal operator is responsible for moving the container.

U.S. Importers. Each of the containers shipped from Thailand to Seattle as part of STAR-BEST were received in the United States by the American divisions of the same company that shipped them—Thomson, Expeditors and Unicord. Thomson is the world's largest supplier of large color television picture tubes. The majority of Thomson's products in the United States are marketed and sold under the RCA brand name. Expeditors is a global logistics company based in Seattle, Washington. It operates 167 offices around the globe. Among its varied services, Expeditors is a licensed Ocean Transportation Intermediary (OTI) and Non-Vessel Operating Common Carrier (NVOCC). The company offers forwarding, consolidation, and container management services to companies moving Less than Container Load and Full Container Load shipments.

U.S. Trade and Development Agency (USTDA). USTDA provided a grant to fund the STAR-BEST Project, including this cost-benefit analysis. Geoffrey Jackson, USTDA assistant to the director for policy planning and regional director for Asia, spoke at the STAR-BEST press conference held in Seattle on October 8, 2003. Mr. Jackson said, "Security and related trade facilitation measures are important to the growth of worldwide trade. Economies must promote the efficient and reliable movement of people and goods across borders to remain competitive, while preventing the tools of transport from becoming the tools of terrorism."[11]

E. Stakeholder Analysis

BearingPoint and Savi conducted a number of interviews to gain the feedback of stakeholders regarding the STAR-BEST Project and the potential for further implementation of an RFID network solution. Interviews with Thai-based stakeholders were conducted in Bangkok and Laem Chabang during the third week of September.

BearingPoint and Savi employees interviewed senior representatives from the following organizations:

- Thailand International Freight Forwarders Association (TIFFA).
- Laem Chabang International Terminal (LCIT).
- Evergreen Container Terminal.
- Unicord PLC.
- Port Authority of Thailand.
- Laem Chabang Port Customs Bureau.

Each interview lasted approximately one hour. The interviews focused on gaining a perspective on each organization's processes and metrics. In addition, the interviewers wished to gain an understanding of how the stakeholders felt about the technology and its potential to improve their organization's performance.

The overwhelming concern was the cost of implementing the network solution on a broad and permanent basis. The Thai stakeholders could envision how the technology would help customers in the United States streamline their supply chains, and they understood that the solution could help allay security concerns. However, any benefits to the Thai stakeholders were not readily apparent. The shipping (exporting) companies are concerned that they will become responsible for paying for the solution at the demand of either their customers or the U.S. government.

None of the STAR-BEST Project participants believed that implementation of the solution would require any major process changes. However, many of the stakeholders believed that the recently tightened security requirements to export goods to the United States had caused hardships. Compliance with the 24-Hour Advanced Manifest Rule, the Container Security Initiative, the Customs' Trade Partnership Against Terrorism (C-TPAT), and C-TPAT Smart Container programs had required increased paperwork, process changes and uncertainty. As a result, participants added buffer and lead times to ensure process handoffs were met in shipment cycles. For example, the Port Authority has had to route all containers bound for U.S. ports through a single gate. This process change has added operational complexity, lengthened delivery distances and times, and generated traffic problems in and around Laem Chabang. These initiatives have made many of the stakeholders wary about what new requirements could be added in the future.

Exporters could foresee one direct and immediate benefit from a broad implementation. Currently, Unicord PLC is charged $25 per container by its freight forwarder to cover expenses related to complying with the 24-Hour Advanced Manifest Rule. Theoretically, this cost would be avoided using the solution because a container's manifest could be sent directly to the U.S. Customs Advanced Manifest System (AMS). The freight forwarder would be relieved of the responsibility.

The terminal operators at the port gave mixed forecasts regarding the technology's potential to improve their operations. Evergreen thought process improvement was possible and believed that offering the technology could serve as a competitive advantage to gain customers from other terminals at Laem Chabang. LCIT disagreed. Chris Langford, LCIT's chief executive officer, did not believe that his terminal's operation needed such technology and doubted that it could serve as a way to attract business. However, Mr. Langford agreed that the technology was largely unobtrusive and would readily accept a permanent installation if his customers demanded it.

II. Business Model

To simplify the understanding of the potential cost and benefits of the network solution, the financial modeling of the cost-benefit analysis is based on a "service provider" business model. While multiple different operating structures are conceivable, the business model and its assumptions have been simplified so that a single entity designs, deploys and operates the required infrastructure and networked information systems. The service provider, in turn, charges shippers a per container fee to utilize the network. The cost-benefit analysis works on three levels:

- First, the cost to the service provider toestablish and maintain the network must be balanced against the benefits the service provider accrues through per container revenue.
- Second, the costs per container that a shipper will pay must be balanced against the benefits realized through greater supply chain security and efficiency.
- Third, the public, particularly the American public, will accrue some benefit from the system in terms of increased security and a lower probability of a terror attack utilizing shipping containers.

Alternative models for deployment of the network solution include allowing multiple service providers to serve different trade lanes or a consortium of companies joint venture ownership of the solution.

In either of the latter cases, it is likely that the permanent hardware (readers and signposts) would be locally owned and service providers would pay infrastructure owners rent to use the equipment. While this system might be the easiest to "stand up" from a financial point of view—smaller organizations with access to less capital could afford to participate—modeling costs and benefits are simplified by assuming one global service provider operates a broad network over multiple trade lanes. In a multiple service provider scenario, each party would share in the costs and revenues associated with the system. In either case, the overall return on investment should be virtually the same.

A. Participants

Service Provider. In this hypothetical business model, the service provider role could be played by a number of organizations. A terminal operator or shipping company could be best positioned, but other possibilities include logistics companies, large technology companies or new ventures created solely to operate the network. Key success factors will likely include an international presence, detailed knowledge regarding the mechanics of international trade, and sufficient capital to build a robust, multi-port, multi-terminal network.

Shippers (Exporters and Importers). Any company that ships containerized goods from foreign ports to the United States could be a customer. They would pay to place RFID tags on containers and monitor the containers' movements through the supply chain. Shippers would pay for the following value components:

- Improved visibility from better predictability and timeliness of cargo shipments.
- Cost avoidance related to emerging U.S. Custom's trade security measures.
- Reductions in safety stock and inventory carrying costs from improvements in trade compliance and in-transit visibility.
- Improvement in customer service to sales channels and resellers.
- Revenue increases from improved in-stock rates.

- Reductions theft and pilferage incidents and direct costs.

Port and Terminal Operators. The organizations that own the physical infrastructure upon which the supply chain relies and upon which the network will have to be built will play a decisive role. Their participation is critical. It is unclear if they will have the market power to levy right-of-way charges or if allowing network installation will simply become a "qualifying" criteria for the ports and terminals to maintain business with shippers moving goods to the United States.

Carriers. The companies that actually move the containers from port to port potentially have the most to lose and the smallest to gain from this technology. Many of the carriers already provide EDI services that attempt to track containers once on board ships. The STAR-BEST solution tracks containers across a multimodal environment and throughout the entire transportation process. Carriers competing on the basis of EDI services could lose market power and, perhaps, pricing power. Additionally, if customers insist that the carriers only use transshipping points equipped with RFID technology, the carriers operating flexibility would be further restrained.

U.S. Customs. While the Customs Service is not a direct participant in this business model, the organization's willingness to recognize the technology's value in lowering threat levels is important to the business model's success. Twenty-four hours before a container is placed on a vessel bound for the United States, the containers' manifest must be provided to the Customs Service. Carriers and freight forwarders are incurring heavy costs by manually loading and transmitting the data into customs' AMS. However, under this new business model, manifest information would be sent electronically to customs and the carriers would not have to become involved. The financial analysis assumes that customs will accept this procedure.

Many of the benefits promised by STAR-BEST require that customs recognize the solution as a risk reduction factor in the ATS. The ATS assigns each U.S.-bound container a risk score based on a number of variables, including country of origin, carrier, shipper and manifest information. In this scenario, containers equipped with RFID-sensing devices originating from trustworthy exporters will be considered a low risk, and the probability that one of these containers will be held up for inspection should drop. For example, if 2 percent of average containers are selected for customs inspection, an RFID-tagged container might only be selected for inspection 1 percent of the time. Customs has not declared an official policy, and the extent to which the inspection rate will fall is uncertain, but customs has indicated that C-TPAT Smart Container will be the price of admission for the highest level of benefits.

Robert Bonner, commissioner of U.S. Customs and Border Protection (CBP), was recently quoted by the Journal of Commerce Online[12] as affirming favored status to importers utilizing "smart container" technology. Mr. Bonner said, "Those companies that use the 'smart container' will be seen by the CBP as companies that go the extra mile to secure their supply chains. It will be those companies around which we will build the true 'Green Lane' of commerce into the United States."

B. Interactions

The vast majority of the interactions and data exchanges required within this business model should be automated, and they should flow through the service provider's network. Each time a container with an attached RFID tag is within the vicinity of a reader or signpost, the container's location and status are recorded and updated immediately on the service provider's network. The shipper (exporter and/or importer) can monitor each container's journey and adjust expected arrival times and inventory levels as appropriate. A diagram of the interactions facilitated by the RFID technology is presented in Figure 1.C.1.

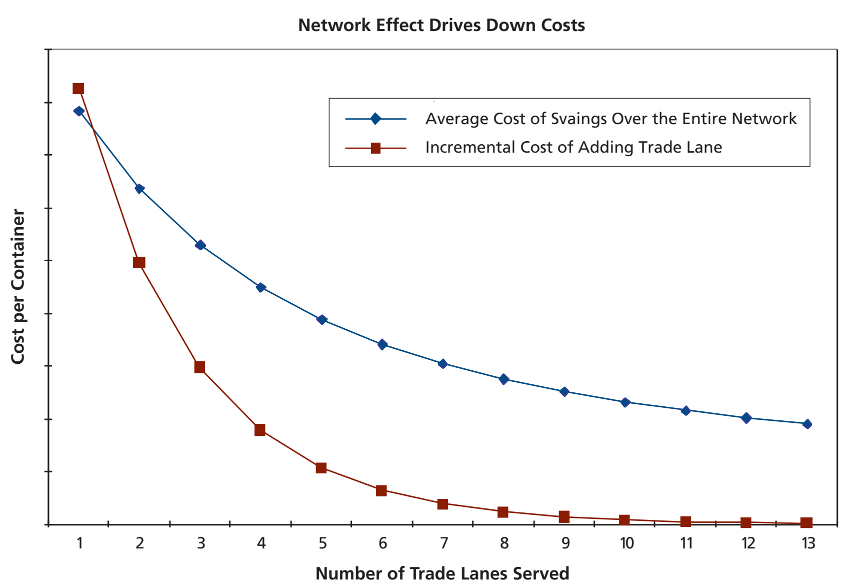
The physical movement of the container should remain the same. Exceptions include possible reduced wait times at the origin port resulting from automated compliance with the 24-hour Advanced Manifest Rule, reduced average inspection times at the U.S. port resulting from an improved risk assessment in the ATS, and the elimination of inefficiency such as route deviations and unnecessary dwell times at other points along the supply chain resulting from greater oversight.

Pre-positioning the RFID tags could be the one area in which interactions will not necessarily be automated. This task could require substantial effort by both the service provider and the customer. The RFID tags could be designed for either one-time use or for multiple uses. Tags designed for one-time use would greatly simplify the process. The service provider would simply have to ensure that each customer had enough tags on hand at the container-stuffing facility to meet demand. If the tags are designed for reuse, the service provider will have to coordinate with customers to return the used tags, and then the tags will have to be shipped back to the origination points. The cost difference between the two tag types remains unclear.

C. Network Effect

The "network effect"—the phenomenon whereby a service becomes more valuable as more people use it, thereby encouraging ever-increasing numbers of adopters—presents both barriers and opportunities for the implementation of this system. As detailed in Section 3, the solution's early adopters will be companies who transport relatively valuable goods in containers. The solution's early cost will be high but will drop as volume is created.

FIGURE 2.C.1.
NETWORK EFFECT



The solution will become a more valuable resource as infrastructure is built throughout the world. U.S. companies import goods from a large number of countries and ports. As the system is installed in more ports, it becomes easier for large companies to migrate toward this technology as the supply chain tracking system of choice. Additionally, since trade lanes share ports, adding new trade lanes becomes cheaper and cheaper. For example, imagine four trade lanes: A to Y, A to X, B to X, and B to Y. Adding A to Y requires new infrastructure at both A and Y. Adding the A to X trade lane only requires new infrastructure at X. Adding B to X only requires adding equipment at B. At this point, the B to Y trade lane becomes a de facto member of the network without adding any infrastructure. The service provider is able to increase revenue without adding expenses and the cost of service drops.

Figure 2.C.1 illustrates the concept. While the data used to construct this chart is hypothetical, it demonstrates what should happen as a network solution is deployed around the globe. The cost of adding trade lanes to the network falls with each new implementation. These benefits are shared uniformly across the network. Unless subsidized initially by the service provider, early adopters will have to pay a premium in the early stages to access the network, but as the costs of operating the network are spread across new users, those premiums should gradually decline.

The solution can also be implemented at other intermodal connections. The technology can be deployed in rail yards, truck depots and key intersections. Inventory can be tracked across entire transportation networks with a single interface. Network effects as described above also accrue as the solution is deployed across these other transportation modes.

III. Financial Modeling

A. Approach

As described in Section 2, the financial model developed for the cost-benefit analysis is, in fact, a series of three models. The first determines the costs a service provider would face in building and maintaining an effective container tracking system based on RFID technology and the resulting price point it would have to charge to receive a fair and equitable return on its investment. The second cost-benefit analysis calculates the benefits customers would accrue by using the RFID tracking system and compares the results to the price point of the service provider. The third model attempts to measure the benefits that the public would receive from this system's implementation.

The costs to build and maintain the system were provided by Savi. The costs are broken down into three primary areas:

- The cost of the actual hardware—RFID tags, readers, and signposts.
- Service costs associated with planning, designing, configuring and installing hardware.
- Service costs associated with maintaining a secure, accessible and timely network.

The forecasted benefits were drawn largely from interviews with shippers, terminal operators, port authorities, customs officials and technology experts. The customers used in the financial modeling are representative models of different companies involved in the shipment of goods between Thailand and Seattle.

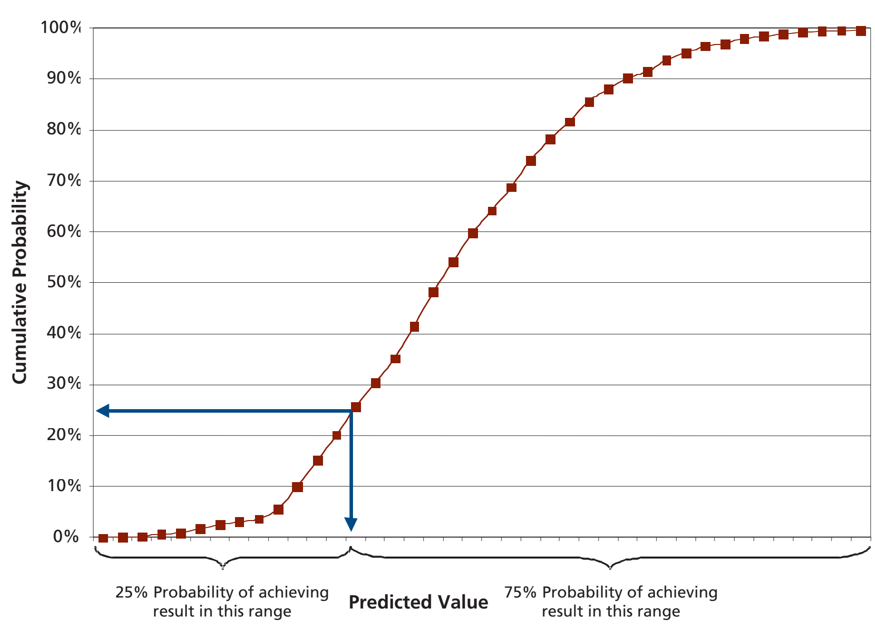
Once assumptions for the model had been determined, the results were tested for sensitivity and variability using risk analysis software that performs

Monte Carlo simulations.[13] Traditional modeling techniques focus on best, worst and most likely scenarios. Such an analysis provides a limited perspective. Utilizing risk analysis software allows the user to gain an understanding of the probability of achieving certain results, the importance of various assumptions in reaching those results, and the interactions between the assorted assumptions.

For example, assume that a financial analysis depends on a number of variables. With traditional modeling techniques, the best case would incorporate the best possible values for each variable, and the worst case would use the worst possible values for each variable. Analyzing other potential combinations, while possible, is time consuming and difficult. A Monte Carlo simulation allows the modeler to quickly attain hundreds or thousands ofpossible results and understand the probability of each occurring. Decision makers are given increased flexibility to set decision points. For instance, if it is determined that an investment will be made only if there is a 75 percent probability that profit will result, the Monte Carlo simulation enables a clear-eyed examination of forecasted results and the ability to test that 75 percent level (See Figure 3.A.1). Traditional methods provide much less precision and leave much more guesswork.

The potential costs of a terrorist attack staged with a shipping container and the resulting benefits from lowering the risk of such an attack are drawn from a number of studies done since the attacks of September 11, 2001. Sources include papers prepared by Abt Associates Inc., the Congressional Research Service and the Organization for Economic Cooperation and Development. A detailed financial analysis relating to the risk of a terrorist attack was conducted separately from the economic cost-benefit analysis, and it is detailed in Section D below.

FIGURE 3.A.1.
MONTE CARLO EXAMPLE



B. Assumptions

This cost-benefit analysis is built on a series of assumptions regarding the scale of the solution, the operating characteristics of potential customers and the willingness of various organizations to accept the solution's capabilities. Given the complexities and uncertainties that are present in both intercontinental supply chains and technological innovation, many assumptions have been assigned probability distributions rather than static values to reflect uncertainty and natural variation.

B.1. Service Provider Cost Assumptions

Solution Scale. The model assumes that the service provider only deploys the solution for container traffic between Thailand and Seattle. However, in order to make the service attractive to a large number of shippers utilizing that trade lane, the service provider will have to implement a fairly robust system. RFID readers and signposts will have to be installed at multiple terminals within the ICD in Thailand, at multiple terminals at both the Laem Chabang and Seattle Ports, and at key transshipment ports in the Asia-Pacific region. Within each terminal at the ports, readers will have to be installed in a way to ensure that both a container's arrival and departure are recorded. Additionally, the solution requires the use of handheld readers at the origination and delivery points.

Service Provider Costs. The costs that a service provider will incur fall into three categories: infrastructure, implementation, and operation costs. Infrastructure costs include the network equipment installed permanently at ports and terminals, RFID seals applied to each container and handheld readers at customer specific locations. Implementation costs include personnel and travel expenses required to assess, design, implement, test and analyze the system. Operation costs include the maintenance of the existing infrastructure and the costs of operating the information database and interface. Understanding that a service provider will be required to make a large, upfront investment to build out the system before any revenue has been realized, the financial model analyzes the net present value of installing and operating the solution over the next five years.

Critical cost assumptions include:

EXPENSE	COST	FREQUENCY
Infrastructure	$436,389	One time
Implementation	$3,433,046	One time
Variable	$86	Per container
Operating	$100,000	Per year

For the purpose of financial modeling, it is assumed that the service provider's cost of capital is approximately 10 percent, that the system will take approximately six months to install, that all of the installed equipment will depreciate fully over five years, and at the end of five years the equipment will retain approximately 20 percent of its new value.

B.2. Customer/Shipper Benefit Assumptions.

The model assumes that the typical customer of the solution produces goods in Thailand and transports the inventory in shipping containers to Seattle. It is assumed that all of the associated containers are stuffed and sealed at a single location, moved by truck to the ICD, moved by train to Laem Chabang, loaded on a vessel and shipped to Seattle. In Seattle, the containers are all moved to a single distribution center. It is assumed that the shippers' containers are moved through a number of terminals at the ICD and at each port.

The assumed operating metrics that were used to construct the financial model are listed in the Appendix. The starting point for the assumptions represents the operating characteristics for a company shipping relatively expensive finished products. Applying a standard deviation to each variable and running the resulting statistical distributions through a Monte Carlo simulation allows for a measurement of how benefits change with operating realities.

An analysis of shippers' supply chains has revealed six areas where savings are likely to be realized from the implementation of the RFID tag and electronic seal system:

1. Inspection expenses.
2. Safety stock costs.
3. Bill of lading (BOL) surcharges.
4. Pilferage costs.
5. Insurance costs.
6. Legacy tracking costs.

Different timelines and levels of confidence are associated with each of these savings areas. Some of the savings are virtually guaranteed and could be realized immediately. Other savings are highly dependent on how well the customer utilizes the available data, and any savings could take a significant amount of time to fully realize. It will be necessary to apply a risk premium to each of these savings categories when comparing benefits and costs.

1. Inspection Expenses. U.S. Customs currently inspects a small percentage of containers that arrive at U.S. ports. While the risk that any one container will be selected for inspection is small, the costs incurred by the importer in such a case can be high. The delay in getting the container from the port to the distribution center adds to carrying costs. Random inspections add variability to expected transit times and force the importer to increase safety stock levels. Customs has raised the possibility that inspections could be reduced for containers originating from companies in compliance with C-TPAT. It is assumed that containers utilizing the RFID solution would receive even more favorable inspection rates. A substantial drop in the probability of inspection could lead to substantial cost savings.

2. Safety Stock Costs. Safety stock—the amount of inventory that must be kept on hand to ensure a target service level—is highly dependent on transit time magnitude and variance. Reducing the time it takes goods to be delivered to distribution centers, and the variability in that time, reduces the amount of inventory a company must maintain on hand to guarantee service.

The network solution has the capability of reducing both time and variability. The time containers dwell in Laem Chabang could be reduced by automatic compliance with the AMS. The average time it takes to move through the Port of Seattle would be lowered if inspection rates were reduced. What was most revealing in trials were the wide variations in container dwell times at the Port of Seattle. Container dwell times ranged from zero (just hours) to nine days once the container was discharged, and the average container dwell time was a full two days.

Variability would also drop as more containers move straight from the terminal to the distribution center and as logistics personnel are empowered to optimize decisions based on real-time information. RFID allows for greater supply chain visibility and confidence because the physical events of container flows are closely connected to the data flows. The system provides exceptional management and decision-making capabilities to the shippers as problems arise. This leads to further potential for savings. The system will identify inefficiency in the supply chain—unnecessary delays at ports, multiple transshipments, misdirected containers—and alert shippers immediately. Shippers, in turn, can immediately act to correct the problems.

It will take time for these savings to be realized. A shipper will need to adjust internal systems and processes to take full advantage of the opportunities this system presents, and confidence in the system will build slowly. This is especially true for the network's "early adopters" who will want to test the technology. It will take additional time for a company to recognize the time savings and reduce safety stock levels accordingly.

Additional savings could flow from a reduced risk of missed sales due to stock-outs. Missed sales occur when an ordered item is not in stock and the customer chooses to buy a competing product rather than wait for delivery. However, using RFID tags, a business can give a customer a precise date of delivery and expected wait time. Knowing for sure when the product will arrive could lower a customer's willingness to select a competing product and thus reduce the number of missed sales due to stock outs. Any reduction in this critical variable could dramatically improve revenues and gross margins.

This analysis assumed that shippers are importing finished goods and having them delivered to distribution centers. However, in some cases, components are being imported and delivered to manufacturing facilities in the United States, utilizing just-in-time processes. As with distribution centers, these manufacturers must maintain a certain safety stock in order to ensure continuous production. When inventory runs out, instead of missing sales, costs are accumulated in the form of decreased capacity utilization. An idled manufacturing plant can cost a company dearly, and the savings offered by the RFID solution potentially could be larger in this environment than in a distribution center operation.

3. BOL Surcharges. Carriers charge shippers a per container service fee to comply with U.S. Customs 24-Hour Advanced Manifest Rule. The shipper provides the manifest to the carrier, which then forwards the data to the AMS. The proposed solution should enable the shipper to record and transmit the manifest directly to AMS and avoid paying the carrier surcharge. Interviews with shippers placed the cost of such a service at about $25 per container. Additionally, carriers often require that containers arrive early at the port to ensure compliance. This delay increases inventory costs for the shipper, and it could be avoided by ensuring that the manifest is delivered to AMS the same day the container leaves the stuffing facility. During the pilot project, manifests for 29 of the 30 containers were provided to the system well ahead of deadline.

4. Pilferage Costs. Depending on the value and type of inventory, many shippers contend with pilferage of contents from containers (shrinkage) and the outright disappearance of containers. It is assumed that this solution will reduce pilferage incidents by acting as a deterrent. Additionally, when pilferage does occur, the attached RFID tag should immediately transmit an emergency signal. Notification allows the shipper and carrier to take immediate action to either stop the act in progress or begin dealing with the disruption immediately. The system can pinpoint the exact location where the intrusion occurred, and, as a result, the shipper has a greater understanding of the supply chain's vulnerabilities. As with the BOL surcharges, savings from reduced pilferage should be immediate.

5. Insurance Costs. It is assumed in this model that insurance premium discounts could be available for containers equipped with RFID tags and electronic seals. The estimated savings are assumed to be small - approximately a 1 percent discount on existing insurance rates. These savings are highly dependent on how the insurance industry views the technology and will likely lag system implementation by a significant amount of time. Insurance rates are based on historical data, and it will take some amount of time to build up a performance history of sufficient size for the insurance industry.

6. Legacy Tracking Costs. In order to track inventory as it moves through the supply chain, importers must contend with a variety of systems and with data that is far from certain. Carriers often provide data to shippers regarding the location and status of vessels and containers, but different carriers use different systems and send the data in a variety of formats. The data is rarely timely and oftentimes incorrect to begin with. Importers must expend significant resources to compile this data and analyze the information. With the solution, importers could track a container's location from one end of the supply chain to the other and eliminate the need for any information from the carrier aside from changes in the expected arrival time of vessels at the receiving ports. Also, because the RFID tags on each container will send automated alerts in the event of an adverse event, less time will be consumed actively tracking and monitoring container movements. Resources should be utilized elsewhere within the organization. With access to more reliable and timely information, logistics managers can make adjustments when exceptions occur and design plans that reduce the probability of recurrence.

The potential savings from a reduction in tracking resources is not clear. It is estimated in the model to be approximately $15-$20 per container. These savings will likely require a significant amount of time to realize. As an added complication, many of these costs are fixed and are used to track costs on a number of different trade lanes. This solution's implementation on a single trade lane might have little impact on tracking costs.

C. Findings

Given the assumptions described above for costs and benefits, the implementation of this solution across the Laem Chabang to Seattle trade lane is financially feasible. The costs of building and operating the solution allows for a price point that ensures financial benefits flow to both the service provider and the Customer/Shipper.

Shipper/Customer. Assuming that all the benefits listed above are achieved, and without accounting for the delay between implementation and cost savings, shippers/importers are likely to realize substantial returns from utilizing this solution. For a shipper moving valuable inventory—$300,000 per container—to the United States, the financial benefits from using the system could range from $200-$2000 per container. Likely savings appear to hover in the $600-$700 range per container. Running the assumptions listed above and those detailed in the Appendix through 1000 iterations in a Monte Carlo simulation produced the probability distribution displayed in Figure 3.C.1. It is extremely important to calculate these benefits before any discounting due to uncertainty has been introduced.

Of course, importers who choose to pay for this service are going to discount the predicted benefits for uncertainty. It is not certain that inefficiency can be driven out of the supply chain or that missed sales can be avoided. It is far from guaranteed that insurance companies will discount premiums or that BOL surcharges can be completely avoided. As a simplified approach, we assume that the shipper/importer has determined that a 50 percent discount needs to be applied to the projected benefits. In other words, the company believes that only about $1 of every $2 in projected savings is likely to be realized. In this scenario, a forecasted benefit of $650 is discounted to about $325.

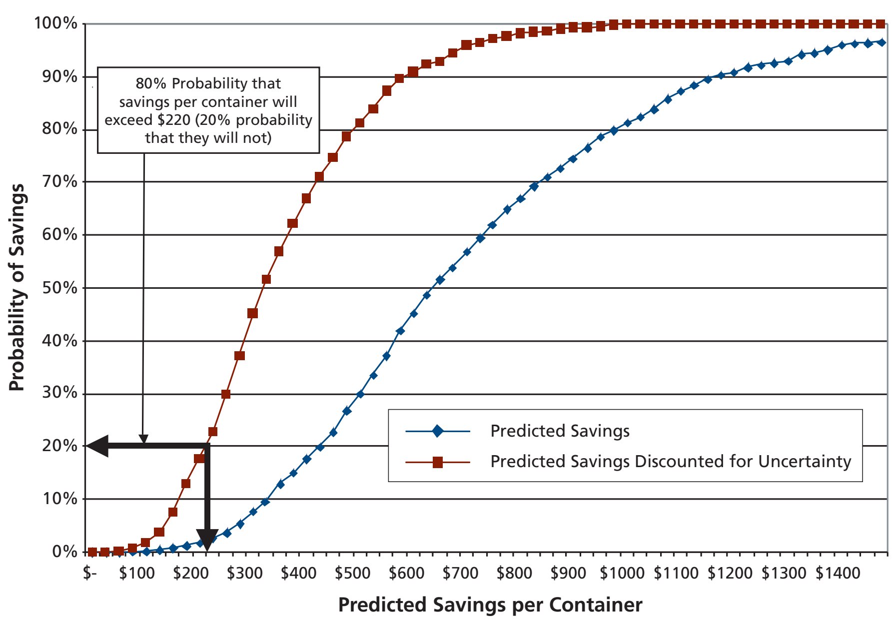
Additionally, a customer would likely demand a reasonable level of certainty that a positive return will be realized. For example, an importer might determine that it needs to be 80 percent confident that the costs will not exceed the benefits. The analysis shows that the importer can be 80 percent confident that the benefits will exceed $220 per container. Therefore, the importer is likely to utilize the solution only if it is priced below $220 per container. Figure 3.C.1 displays the probability distributions and highlights the 80 percent probability level.

The largest benefits are derived at the importer's distribution center. Safety stock reductions and fewer missed sales are responsible for a majority of the projected savings. Most of these savings are directly attributable to four key variables (assuming that an importer's inventory carrying cost is held constant):

- Value of goods per container.
- Transit time.
- Transit time variance.
- The ability to reduce missed sales due to stock outs.

The costs are accumulated on a per container basis, but the benefits are linked to the value of the goods inside the container. It is simply more expensive to have high-priced goods sit in inventory than low-priced goods. Hence, the greater the value of goods per container, the greater the benefits the importer will realize on a per container basis. Most of these

FIGURE 3.C.1.
PROJECTED SAVINGS TO IMPORTERS GENERATED BY SOLUTION IMPLEMENTATION



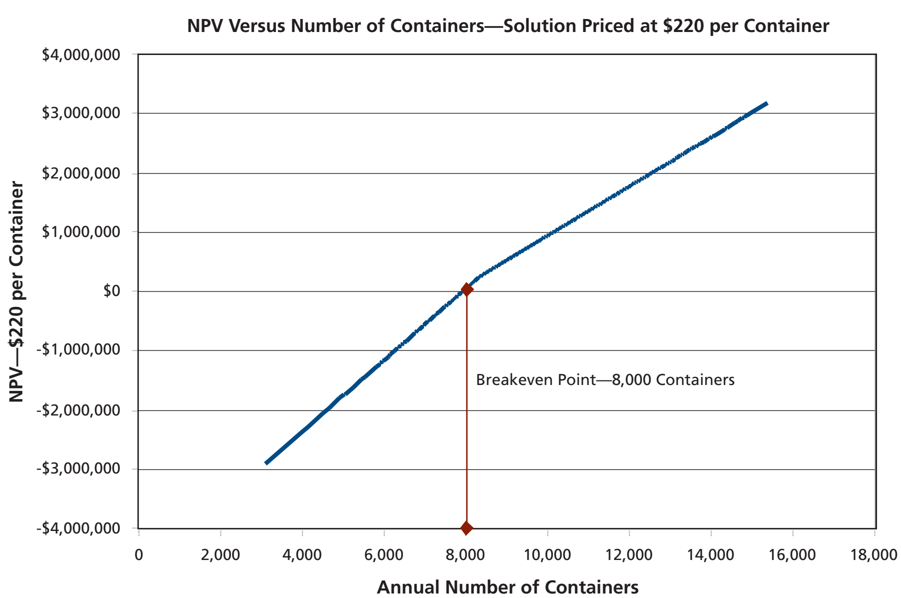
savings will be impossible, however, if the transit time and variance cannot be reduced. Containers must be moved more quickly and with fewer disruptions through the ports in both Thailand and Seattle in order to reduce safety stock. Finally, businesses must be able to use greater supply chain visibility to retain customers who might occasionally have to wait a day or two for a product.

Charts graphically displaying the impact each of these four variables has on the expected benefits are shown in the Appendix.

The benefits achieved by reducing BOL surcharges, insurance premiums, direct inspection charges and pilferage losses are straightforward but offer limited benefits. Without significant savings in the time it takes to transport goods and the amount of inventory a company needs to keep on hand at the distribution center, the savings are not likely to approach the level required to invest in the system.

Service Provider. The financial viability of a full-scale implementation of the solution across the Laem Chabang to Seattle trade lane is heavily dependent on three key factors: volume, revenue per container and implementation time. To gain profitability, the service provider must cover both variable and fixed costs. At a minimum, the revenue per container must meet the variable costs. In this case, the RFID tag and bolt cost of approximately $85 serves as that bottom range. As the revenue per container increases, the number of containers that must be moved through the system decreases. Given a likely price point of approximately $220 per container and the cost assumptions discussed above, the service provider would need to deploy a solution to support approximately 8,000 containers annually to realize positive returns over five years. Figure 3.C.2 displays the relationship between the service providers expected net present value (NPV) as container volume changes. Since roughly 20,000 containers are shipped from Laem Chabang to Seattle each year, approximately 40 percent of the traffic on this trade lane would need to be equipped

FIGURE 3.C.2.
NET PRESENT VALUE VERSUS CONTAINER VOLUME



with RFID technology. Of course, as more trade lanes are added, the cost per container will drop and the potential number of customers will increase.

D. The "What If" Scenario

What if a terrorist group takes advantage of the current international trade system by placing a large, devastating weapon inside a shipping container bound for the United States? What is it worth to the government, the economy and the public to stop such an event from occurring? When attempting to determine the value of this solution to the public, three questions must be answered. First, what would be the cost in lives, property and economic decline that would result from an attack using a weapon of mass destruction delivered to the United States in a shipping container? Two, given the current security environment, what is the probability of such an attack occurring? Third, how much is the probability of such an attack reduced by implementing this solution?

Abt Associates recently published a paper for the U.S. Department of Transportation that attempts to answer the first question. The Abt paper was based on the assumption that a medium scale atomic weapon was detonated within or near a major urban area. The authors estimated that the direct cost of such an attack could be 50,000 fatalities, 300,00 injuries and an economic cost of nearly $300 billion. In addition, the attack would likely cause a substantial drop in gross domestic product—upwards of 2 percent, or $200 billion. Finally, the authors assume that the U.S. government would spend another $300 billion on the investigation and subsequent security upgrades. The total cost would be nearly $800 billion.

The detonation of an atomic weapon is the worst case scenario involving shipping containers. The movement and use of chemical or biologic agents or non-atomic radiological weapons via a shipping container have also been raised as potential dangers. The probability of an attack utilizing these weapons is probably greater than the odds that a fully functioning atomic weapon will be detonated. However, the cost, both direct and indirect, will likely not reach the $800 billion range.

If a devastating atomic attack was a near certainty in the next year and given a cost of $800 billion, the U.S. would be willing (theoretically) to invest nearly $800 billion to avoid such an attack. Since roughly 7 million containers enter U.S. ports every year, the expenditure of $114,000 per container ($800 billion/7 million) would be justified. However, this investment would only be wise if the ability to stop the attack was guaranteed and if the likelihood of an attack was 100 percent. In reality, the probability of either the attack taking place or the solution's ability to prevent such an attack is far from 100 percent. Estimating the actual odds of an attack and the solution's ability to stop it are beyond the scope of this paper. It is clear that the solution can provide enhanced security to containers as they move through the supply chain. It would be impossible for a terrorist to open a container's door and insert a weapon without being compromised. Additionally, the use of the solution in tandem with the C-TPAT and Container Security initiatives enhances U.S. Customs' ability to target truly suspicious containers for inspection. However, the container is hardly rendered impregnable.

While the benefits from increased supply chain efficiency make the deployment of this solution advantageous to importers in the United States, the benefits the solution provides to transportation security are difficult to measure with the limited test information. Other supply chain security initiatives currently underway are studying the vulnerability reductions to be expected in deployment of this technology, and it is expected that they will provide additional information to assess the security improvements quantitatively.

Private Sector. The private sector might decide that there is value to funding the solution in order to prevent a devastating terror attack. A good deal of the costs resulting from a terrorist attack will heavily impact companies involved in international trade. Importers likely could experience a large reduction in sales, brand erosion, damaged infrastructure, capacity reductions, employee fatalities and injuries, and increased barriers to trade. While the costs of such an attack would be devastatingly high, it is extraordinarily difficult to place a figure on the probability of such an incident. As with the costs and benefits to the public, it is difficult to estimate the price a company should be willing to pay to avoid such an attack.

We can however, make some conclusions regarding the dramatic impact such and event will have on ports and shippers. The targeted port would likely be closed for a year, and every other port in the United States could be closed for a significant period. Companies relying on imported goods that transit these ports would be financially devastated. For example, assume a company whose gross margin per container is $120,000 (40 percent of $300,000) expects to lose nearly 80 percent of its annual sales in the event of an attack. The expected loss on a per container basis would be nearly $100,000.

Findings. The "what if" scenario presented in this section describes an attempt to predict the economic impact of a catastrophic event and the potential savings associated with implementation of this solution. These savings would be directly attributable to the ability of the solution to prevent the event from happening or to mitigate its impact. We find that the currently available information on the likelihood of an event occurring and the reduction of the likelihood afforded by implementation of the solution are not adequate to make any reasonable quantitative estimates. Other supply chain security initiatives currently underway are studying the predicted vulnerability reductions in deployment of this technology, and it is expected that they will provide additional information to assess the security improvements quantitatively in the future. Nonetheless, it can be stated that implementation of the solution will likely have a positive impact on security in addition to the quantifiable economic benefits that result from improved supply chain efficiency. While economic benefits related to security improvements are likely to occur, they are not required to justify implementation of the solution.

E. Conclusions

The end-to-end supply chain security solution provided by Savi Technology and tested by the STAR-BEST Project is financially feasible. Companies importing goods into the United States should realize impressive financial benefits by utilizing this technology to secure, track and manage their supply chains. These benefits are as follows:

- Improvement in visibility from better predictability and timeliness of cargo shipments.
- Cost avoidance related to emerging U.S. Customs' trade security measures.
- Reductions in safety stock and inventory carrying costs from improvements in trade compliance and in-transit visibility.
- Improvement in customer service to sales channels and resellers.
- Profit increases from improved product in-stock rates.
- Reductions in incidences and direct costs of theft and pilferage.

The majority of these result from greater supply chain visibility, transparency and process improvements that will allow importers to reduce transit time variations and inventory safety stocks. A quantitative summary of per container benefits to a shipper and a solution provider are as follows:

- Aggregate benefits range anywhere from $150-$2000 per container.
- Adjusted conservatively for uncertainty and risk, there is an 80 percent probability that benefits will exceed $220 per container.
- The break even of the solution in this trade lane is 8,000 containers based on $220 per container pricing by the service provider. A service provider who deploys a working solution based on this technology should be able to recoup its cost and earn healthy returns.

While the benefits from increased supply chain efficiency make the deployment of this solution advantageous to importers in the United States, the benefits the solution provides to transportation security are difficult to measure with the limited test information. Other supply chain security initiatives currently underway are studying the predicted vulnerability reductions in deployment of this technology, and it is expected that they will provide additional information to assess these security improvements quantitatively.

Business and Systems Aligned. Business Empowered.

APPENDIX

The following assumptions were used to model the financial costs and benefits to an importer using the solution to improve its supply chain.

FIGURE 4.1
ASSUMPTIONS

ASSUMPTION	MEAN	STANDARD DEVIATION	UNIITS
U.S. Customs Inspection Assumptions			
Time it takes for U.S. Customs to inspect a container	0.25	0.05	Days
% of Containers Subject to Inspection—Current	0.5%		
% of Containers Subject to Inspection as Customs Increases Capacity	0.5%	0.2%	
Green Lane Container Inspection Rate	0.2%	0.1%	
Importer Assumptions			
Annual Demand from Distribution Center	4,400	500	Containers
Monthly Demand Coefficient of Variance	0.7	0.2	
Value of Goods per Container	$300,000	$100,000	
Average Gross Margin for Containerized Goods	40%	5%	
Missed Sale Gross Margin Multiplier	2	0.25%	
% Stockouts That Resut in Missed Sales—Before Implementation	30%		
% Stockouts that resut in Missed Sales—After Implementation	25%	3%	
Annual Inventory Carrying Cost	22%	2%	
Pilferage & Insurance Assumptions			
Pilferage Incidents per Year—Before Implementation	2	1	
Pilferage Incidents per Year—After Implementation	0.5	0.5	
Property Costs per Pilferage Incident	$130,000	$20,000	
% of Pilferage Losses Reimbursed by Insurance	25%	5%	
Administration Cost per Pilferage Incident	$10,000	$4,000	
Shipping Insurance as % of Container Value	2%		
Reduction in Insurance Cost After Implementation	1%	0.50%	
Tracking Cost Assumptions			
Tracking Costs per Container—Before Implementation	$100	25	
Expected Reduction in Tracking Cost (%)	15%	5%	
AMR Compliance/Bill of Lading (BOL) Assumptions			
Average Number of BOLs per Container	1.0		
Time Delay at Laem Chabang Without Load Order	2.0	0.5	Days
Time Delay at Laem Chabang Due to Paper BOL Submission	0.5	0.25	Days
% of BOLs Submitted on Paper	50%	15%	
Surcharge per BOL	$25	5	
Surcharge per BOL Admendment	$40	10	
% of BOLs Requiring Admendments	4.0%	2%	
Transit Time Assumptions			
Average Transit Time (Point of Origination to U.S. Distribution Center)	29.5	6.2	Days
Estimated Change in the Mean Transit Time After Implementation	–2%	1%	
Estimated Change in the Transit Time Standard Deviation After Implementation	–10%	2%	
Number of Days Between Deliveries to the Distribution Center	7	2	Days

The following charts illustrate the relationship between expected benefits for the customer on a per container basis and the four key variables: value of goods per container, transit time, transit time variance and missed sales due to stock outs. For each analysis, all other variables were held constant at the expected value.

FIGURE 4.2
BENEFITS VERSUS VALUE OF GOODS

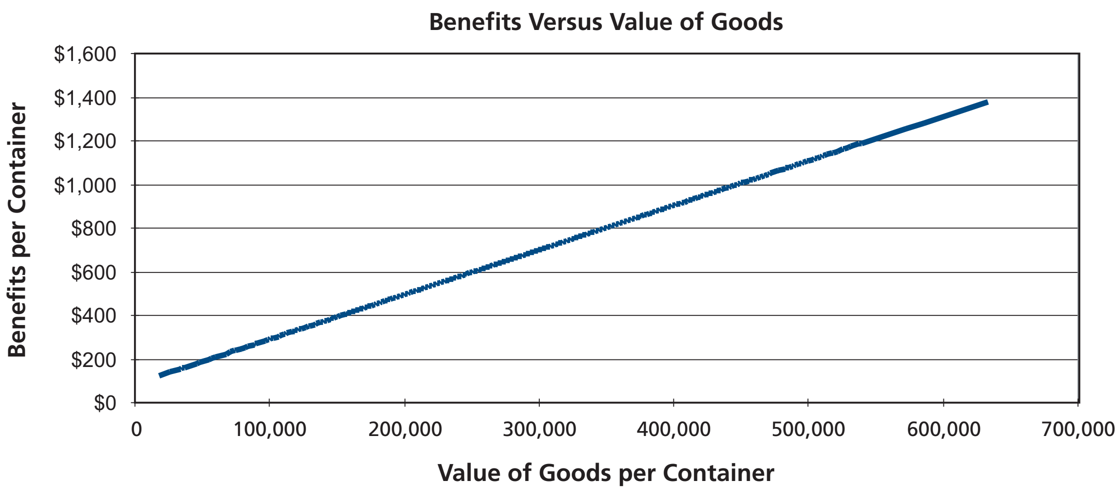


FIGURE 4.3
BENEFITS VERSUS STOCK OUT MISSED SALES

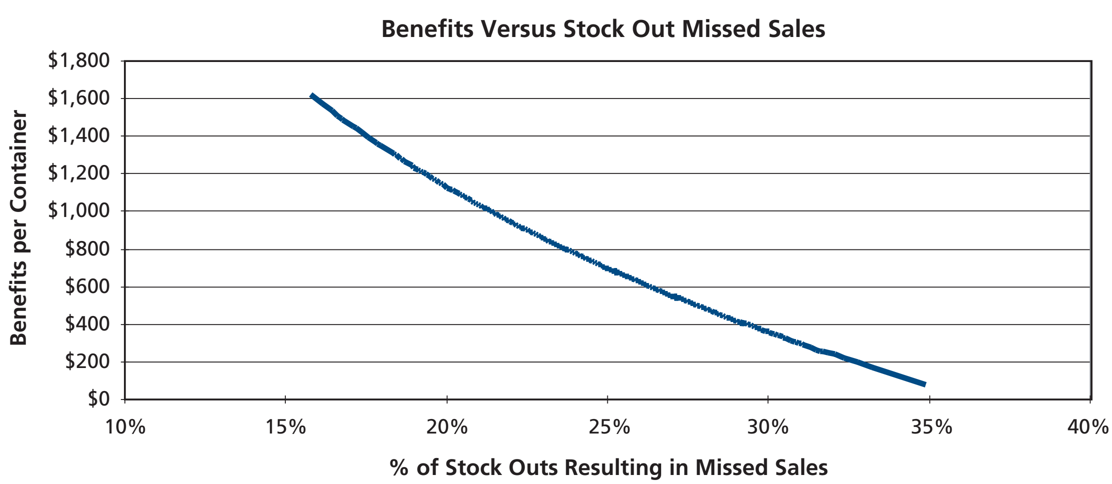


FIGURE 4.4
BENEFITS VERSUS TRANSIT TIME VARIANCE

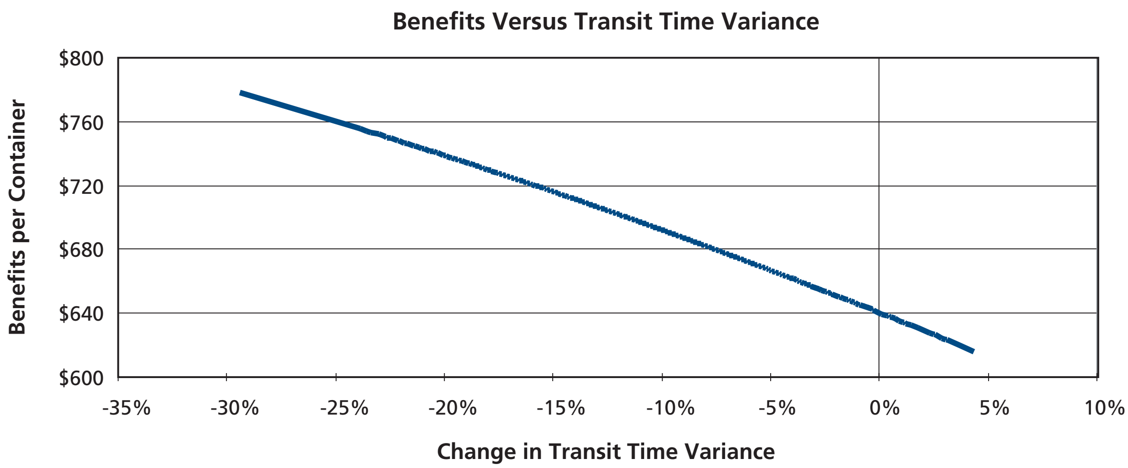
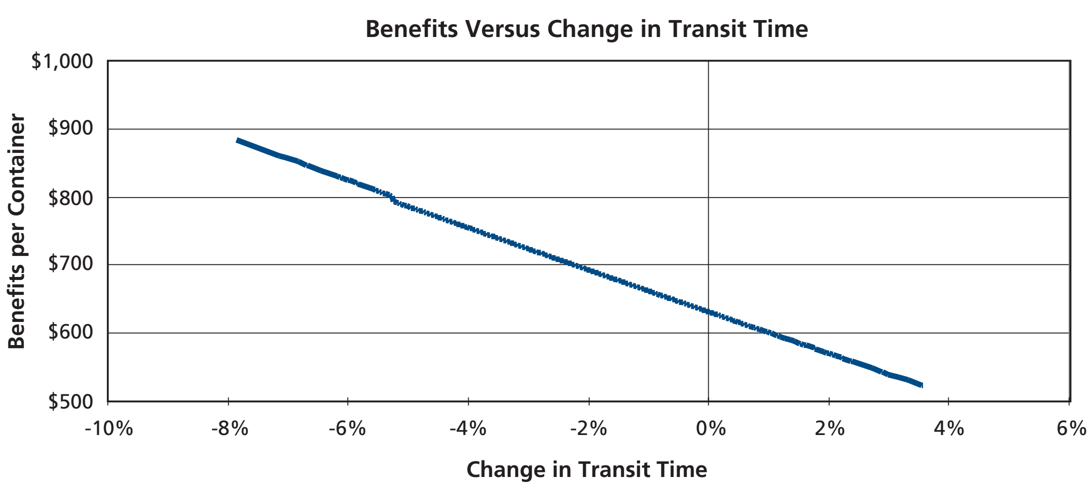


FIGURE 4.5
BENEFITS VERSUS CHANGE IN TRANSIT TIME



Footnotes

[1]Organization for Economic Cooperation and Development, "Security in Maritime Transport: Risk Factors and Economic Impact," Maritime Transport Committee, July 2003, p. 6.

[2]Ibid.

[3]Landewieshe, William, "Anarchy at Sea," *The Atlantic Monthly*, Volume 292, No. 2, September 2003, pp. 50-80.

[4]Interview with Teerayudh Dummanonda, managing director, Laem Chabang Port/Port Authority of Thailand, on September 18, 2003 in Laem Chabang.

[5]Port of Seattle web site, http://www.portseattle.org/seaport/statistics/, Seaport Statistics

[6]Interview with Ajara Mhordee, marketing manager, Unicord PLC, on September 16, 2003 in Bangkok.

[7]Interview with Chris Langford, chief executive officer, LCIT, on September 17, 2003 in Laem Chabang.

[8]Interview with Somyos Srion, manager, Ship Side Operation Section, Evergreen Container Terminal, on September 17, 2003 in Laem Chabang.

[9]Interview with Jongkol Tim-Aroon, director, Goods Inspection and Control Division, Laem Chabang Port Customs Bureau, on September 18, 2003 in Laem Chabang.

[10]Phone Interview with John Nadeau, U.S. Customs, Port of Seattle, on October 8, 2003.

[11]http://www.tda.gov/trade/press/Oct08_03.html.

[12]Barling, Russel, "U.S. Locks Up 'Green Lane' Access," Journal of Commerce Online, November 4, 2003.

[13]Crystal Ball 2000.2 Standard Edition by Decisioneering (www.decisioneering.com).

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