Security Supply Chain

Eduardo Mario Dias, Caio Fernando Fontana, Fabio Hideo Mori, Luiz Paulo Facioli, Paulo José Zancul
Power and Electric Automation Engineering Department
Escola Politécnica da Universidade de São Paulo
Av. Professor Luciano Gualberto, Trav. 3, 158, Room A2-06
BRAZIL

Abstract: - This article provides a model of secure logistic chain, aiming at integrating the electronic seal, tracking and non-intrusive inspection technologies. By using as premises the security concepts and standards set forth by several entities worldwide, among them, CSI (Container Security Initiative), WCO (World Customs Organization) recommendations and the SAFE Ports Act. This model might be applied within the supply chain in order to help in cargo security, by monitoring its inviolability.

Keywords: - WCO, CSI, logistic chain, security, electronic seal, tracking, non-intrusive inspection (6 - 10 words)

1 Introduction
With the growth of terrorist actions and cargo theft in several parts of the world, the logistic control problem became a priority concern in most of the countries. By looking for meeting these needs, the United States of America created several guidelines, such as CSI (Container Security Initiative) and SAFE Ports Act. Other initiatives appeared in all other parts of the world, WCO (World Customs Organization), via Kyoto Convention, defined a Normative Framework for Security and Simplification of International Trade. This WCO Normative Framework, aimed at protecting and simplifying the international trade, establishes principles and standards to be adopted as a minimum level by its members.

The aforementioned cargo theft question is worrying, especially in Brazil. The figure below shows the number of monthly cargo theft occurrences in 2007.

This paper will present a model that has the purpose of defining a system capable of enabling the analysis of scanner-generated images, storing the electronic cargo documentation, external images and telemetry data produced by tracking and electronic seal systems, and providing the cargo-related data over the Internet.

2 Security Concepts

2.1 SAFE Ports Act
The “SAFE PORT ACT”, issued by the American government, encompasses a series of programs to improve security at the United States ports, such as:
- Security requirements for maritime facilities;
- Monitoring of port areas, Vehicles and cargoes;
- Transportation worker identification credentials;
- Identification of workers by biometrical instruments;
- Creation of inter-institutional operational centers for port security;
- Port Security Grant Program (PSG);
- Creation of secure zones within ports, including underwater check with sonars;
- Security initiative for containers, the so-called (CSI);
- Tracking and non-intrusive inspections of containers;
- Security assessment of foreign ports.

Assessment of the security instrument degrees adopted by foreign ports;
- Partnerships with customs authorities to combat terrorism;
- Office for Domestic Preparedness (ODP).
This is the federal agency, within the Department of Homeland Security (DHS) in charge of managing the Grant Program (PSG). ODP will work in partnership with American federal agencies:

- Mechanisms to enable inspections of maritime facilities without prior notice;
- Creation of inter-institutional operational centers for port security;
- Determination and implementation of risk assessment tool;
- Random inspection system for containers;
- Strategic plan for reinforcing the security in the international supply chain (Secure Logistic Chain);
- Security standards and procedures for containers;
- Tracking and scanning of cargo containers;
- Interchange of security-related information for the supply chain, cooperation;
- Information system and data on international trade;
- Determination and implementation of risk assessment tool;
- Random inspection system for containers;
- Assessment determination system for threats and truck tracking at ports;
- Creation of inter-institutional operational centers for port security;
- Determination and implementation of risk assessment tool;
- Random inspection system for containers;
- Assessment determination system for threats and truck tracking at ports;
- Strategic plan for reinforcing the security in the international supply chain (Secure Logistic Chain);
- Security standards and procedures for containers;
- Tracking and scanning of cargo containers;
- Interchange of security-related information for the supply chain, cooperation;
- Information system and data on international trade;
- Investment and development of a strategy and technology for investigation and detection of nuclear and radiological elements;
- Health and safety protection in case of catastrophes.

In addition, the law created the “Domestic Nuclear Detection Office”, within the Department of Homeland Security (DHS), and sufficient funds for developing the underwater program Integrated System for modernizing in the long term the United States Coast Guard (USGC).

2.2 CSI (Container Security Initiative)

CSI, as it is popularly known, or Container Security Initiative, is a preventive program implemented by the Customs and Border Protection (CBP), a body of the American government, similar to Brazilian Customs, and specific for preventing the utilization by terrorists of sea cargo containers forwarded to the USA, and proceeding from any port in the world, which sets forth security criteria for identifying high-risk containers, especially for the eventual existence of Weapons of Mass Destruction (WMD), by evaluation in the origination port, based on risk information and assessment, and using non-intrusive technologies for content checking, in order to enable anticipating the American control at locations outside the USA physical borders.

The referred program comprises specific actions, namely:

- Definition of security criteria to identify potentially suspect containers;
- Analysis and check of containers identified as potentially suspect before their shipment in the origination country;
- Utilization of technology that enables fast check of these containers; and Development and utilization of more secure and smarter containers.

2.3 Standards Structure at the World Customs Organization

This was a strategy enforced by the World Customs Organization (WCO) to check the security on goods circulation in the global trade, in order not to prevent, but facilitate, trade exchange. Protecting the international supply change is only one stage in the overall process for strengthening and preparing the customs administrations for the 21st century. Thus, to strengthen and go beyond the existing programs and practices, the WCO members conceived a process aimed at reinforcing security and facilitating the international trade. This is the WCO SAFE Framework of Standards to Secure and Facilitate Global Trade, also called as “WCO Standards Structure”, “WCO Structure” or simply “Structure”.

Purposes and principles of the structure:

- Establish security standards;
- Implement integrated management;
- Strengthen customs;
- Strengthen cooperation between customs;
- Strengthen cooperation between customs and companies;
- Promote uninterrupted and secure circulation in the international trade.

Four fundamental elements:

- Harmonization of electronic cargo manifest;
- Commitment of the country in managing security risks;
- Upon request from the recipient country, the sender must perform non-invasive inspection of containers and risky cargoes;
- The customs authorities will provide benefits for the companies that meet security standards.

Structure foundations:

1. Foundation 1 – Customs Chain – Customs:

- Collaboration based on common standards and interoperable messages
- Prior information transmitted via electronic means
- Risk determined at the exit port
- Inspection by X or gamma rays and radiation detectors
2. Foundation 2 → Customs Chain – private sector:
   ✓ Partnerships with companies that assure high security level
   ✓ Tangible benefits (fast processing and others)
   ✓ The security is closer to the supply chain
   ✓ Credential granting is made in function of the circumstances
   ✓ Effective customs-company communication (IT)

3 Technologies Used

This topic presents the key technologies to be used in the model to be proposed, among them, electronic seal, tracking and non-intrusive inspection.

3.1 Electronic Seal

The electronic seal is a device used for closure, especially of containers, which provides the capacity of registering in an electronic way their violation occurrences. It may be used independently from the AVL (Automatic Vehicle Location) system. This technology enables tracking large internal areas, by establishing and controlling routes. To do that, antennas must be installed along the path and in the move bottleneck.

The advantages of this device are compatibility with the major AVL systems, low cost and difficult violation and fraud.

3.2 Tracking

The tracking system has the purpose of monitoring vehicles, and thus it is capable of mapping the entire path ran by them, time spent to run the path and stop locations. To do that, there are 3 technologies that may be used in tracking:

✓ Satellite (high- and low-orbit satellites);
✓ Land-based network (by using cell phones and antenna triangulation);
✓ Hybrid (aggregates the Satellite and Land Network technologies).

3.2.1 Satellite

Satellite-based location systems enable achieving the geographical position of a receiver, by the reception of positioning signals proceeding from one or more satellites orbiting the Earth. Normally, the positioning receiver is required to perform calculations for determining, in real time and continuously, its geographical position (longitude, latitude and altitude) at any part of the Earth and under any climatic conditions.

3.2.2 Land Network

The location systems based on land networks enable achieving the position of a receiver by using cellular telephony or antenna triangulation.

3.2.3 AVL System

The AVL system has been increasingly used in vehicle tracking to achieve the position and enable communication with vehicles, also performing associated operations via sensors installed on them. Each sensor type corresponds to an operation type, as shown in the figure below.

3.3 Non-Intrusive Inspection

The non-intrusive inspection uses equipment that enable examining and analyzing contents, without requiring the removal from where they are stored. The major equipment currently used are the scanners, which may use X-ray or gamma-ray technologies. This article only covers the X-ray equipment. This equipment is divided into three types:

✓ Mobile equipment;
✓ Fixed or relocatable equipment, where the equipment moves and the target is fixed;
✓ Fixed or relocatable equipment, where the equipment is fixed and the target moves.

All the types support the installation of radioactivity detectors, identity capture devices, via OCR systems and external images. Other equipment, particularly mass and infrared spectrometers, is frequently used together with X-ray apparatuses for cargo examination.

Thus type of technology is being increasingly used in containers and trucks, and thus article will focus on this utilization.

3.3.1 Principle of Operation

The principle of operation of X-ray equipment for inspection is relatively simple. An X-ray generator, which is usually an electron tube in conventional
small-size equipment and a particle accelerator in large-size equipment, is energized by a power circuit, thus generating X rays. The X-rays generated are aligned by a collimator and form a fan-like beam with small thickness, usually around 1 mm. The object to be inspected passes across this beam – with fixed X-ray apparatus and moving object, or vice-versa. This object is then traversed by the X-ray beam, and in function of its content density, it absorbs more or less energy from the beam, and the X rays that traversed this object hit a column of photosensor diodes, sensitive to X rays, which will emit an electric pulse. Analog to digital converters change these pulses in signals that are processed and finally converted in a digital image on a monitor. This radioscopic image shows the content of the object inspected.

3.3.2 Mobile Equipment
These are autonomous apparatuses, mounted on a truck chassis, which enable their displacement. They are manufactured to be quickly started up in use or prepared for a new displacement. This type of equipment is primarily used by repression units, which must use the surprise element as a primordial factor for cargo examination.

3.3.3 Fixed Equipment with Fixed Cargo and Mobile Apparatus
Also known as “Gantry”. The truck that carries the cargo stops, the driver leaves the cab and this equipment, usually mounted on rails, moves alongside the object to obtain the image. In addition to provide a good speed control, which provides more uniform images, it is possible to examine, in addition to the container or box that carries the cargo, the truck driving cab.

3.3.4 Fixed Equipment with Mobile Cargo and Fixed Apparatus
Also known as Portal (or Pass-Through). This is a piece of equipment where the X-ray apparatus is fastened to the ground and the trucks are driven by their drivers across the portal. The safety devices wait for the cab passing through the portal and trigger the X-ray beam on the cargo container or box. This apparatus type enables higher cargo flow, and is capable of examining, with good image quality, near 120 trucks per hour.

4 Proposed Model
The key idea behind the model is tracking the vehicle and cargo and assuring its inviolability.

Shown below are the services to be used in the secure logistic chain model.

4.1 Physical Inspection of the Container
The physical inspection of the container is a procedure to be carried out upon truck arrival and departure, aiming at checking the container status and its conditions at the analysis time. First, the container seal will be inspected for any eventual violation. Then, the container inspection starts, according to a predefined checking routine made by an operator properly trained. All these stages are followed by photographic records.

4.2 Inspection Level 1
Initially, the special equipment that will perform the cargo inspection must enable:
- Radioscopic image (X rays) of the cargo compartment (container);
- Automatic recognition of the presence of any radioactive material;
- Automatic cargo and truck identification;
- Obtainment of external images of the container and truck.

First, a so-called inspection level 1 will be performed, where the truck runs at an approximate speed of 7 km/h through an equipment, which enables processing approximately 120 trucks per hour per equipment installed. The data achieved are digital, thus forming a file that will be transmitted in real time to a remote server. This information will be then available to any intervening authority (Tax Authority, Federal Police, Sanitary Surveillance, etc), and also other interested parties (importer, exporter, etc), which will be able to access it.

4.3 Inspection Level 2
After inspection level 1, and when identified as suspect, the cargo is submitted to other inspection, called herein as inspection level 2, where the truck with the cargo parks and the equipment moves and
achieves data with higher accuracy than that in the previous inspection, in addition to scan the truck driving cab.

This inspection level employs explosive and narcotic trace detectors and spectrometers to identify liquid and solid substances. Solid residues will be also scanned for analysis, classification and screening purposes.

The data achieved are digital, and similarly as for the inspection level 1, a file is formed and transmitted in real time to a remote server and made available for queries.

In case of suspicion after inspection level 2, the cargo will be removed from the container and submitted to a physical inspection.

4.4 Sealing and Tracking

Also, it will be developed a container sealing and tracking system, which will enable tracking displacements in the run and/or path from the dock to the customs premises, including areas outside the port facilities in order to monitor the route and term established, as well as to assure inviolability of security seals.

To support the proposed model, the optimal solution is the utilization of electronic seals, with satellite-based (GPS) or radio frequency identification sensor technologies, to provide accurate information on the geographical position of the cargo or container.

Among the numerous existing solutions in the market, a monitored padlock-type electronic seal must be used, as shown in the sample illustration below, installed on the container locks, which shall provide the features below:

- Physical security to prevent or alarm its violation;
- Physical or electronic non-repetitive alphanumeric identification;
- Active or passive transmission/reception of signals for run sensors or satellite; and
- Option for reutilization by undetermined time.

It shall be defined the specific place to install the sealing system to be used and routes and terms to be observed by the container carriers in the path between ship and warehouse, and vice-versa, also passing through the scanners’ premises and including a solution for locking the container’s door in order to assure its inviolability, as well as provide control information on the container, especially the one related to locking and opening times, and tracking, thus preventing the cargo displacement to more distant areas or on non-authorized runs.

4.5 Model Process Flow

When arriving to the location where the non-intrusive inspection will be performed, the driver will present the invoices for the goods carried, which will be entered in the system. This information may be sent in advance by the customer in EDI/XML format.

Then, the truck shall be submitted to a physical inspection of the container in order to register its status, by checking that it was not violated.

Next, the truck will pass by Inspection Level 1, and run to the place where the high-flow non-intrusive inspection equipment is installed. The images generated will be analyzed. In case of any suspicion or divergence with the goods information previously entered, the vehicle will be forwarded to Inspection Level 2.

In Inspection Level 2, the non-intrusive inspection will be carried out by more accurate equipment. If the suspicion or divergence remains, the analysis information will be transmitted to the system users, and the parties involved will wait for the measures to be taken.

If there is no suspicion or divergence on the truck and goods, the vehicle will run to the sealing area. At this place, the vehicles to be tracked in the rest of the run will be sealed.

Upon departure, the container on the truck is inspected again.

We must highlight that all these stages will be monitored by electronic and photographic records.

4.6 Information Integration and Management

This model includes the development of a WEB Information System providing the container information and images, which will integrate:

- Scanner System;
- Physical inspection report;
- Electronic documentation;
- Tracking;
- Photographic / video system for the containers.

This portal will link the data proceeding from the systems described above, thus enabling the user to perform several queries.

5 Conclusion

The model presented, in spite of being focused on road modal transportation, can be adapted for railway, waterway, airway and port modal transports. This model will benefit the society as a whole in terms of greater and better control of drug and weapon traffic, and also goods smuggling. Other area benefited with this system is the control on pandemia.
proceeding from other regions and that may affect public health, fauna or flora, by the automation of non-intrusive cargo, solid residue, crew member and passenger inspection systems, aimed at controlling Severe Acute Respiratory Syndrome (SARS). Thus, there are numerous benefits from using the secure logistic chain by federal, state and local authorities, and we may highlight, among others:

- Inter-state tax control (ICMS);
- Sanitary controls;
- Environmental controls;
- Traffic control;
- Logistic control for exportation/importation cargoes;
- Information for systems that combat drug and weapon traffic and smuggling in general;

References: