

Security Logistic Chain Process - Methodology for the Implementation

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Abstract: The development of the Methodology for the Implantation of the Processes of the Safe Logistic Chain aims at to establish parameters and methodology for application of the diverse concepts and programs of security for the foreign commerce being aimed at the load control that come being implemented for agencies of government and international organisms. The implementation of this model will provide to an increase of productivity of the sector therefore the adoption of measures of load control demands that the planning of the logistic operations is effected, followed and corrected whenever necessary.

Keywords: CSI; Safe logistic chain; Security; Electronic seal; Tracking

1 Introduction

The development of the Methodology for the Implantation of the Processes of the Safe Logistic Chain aims at to establish parameters and methodology for application of the diverse concepts and programs of security for the foreign commerce being aimed at the load control that come being implemented for agencies of government and international organisms. These programs have as focus the control on the processes of load movement, through the use of technology applied to the not intrusive inspection of load, electronic tracking and sealing waxes, systems of electronic exchange of information and the systemic integration of these components. In such a way, this thesis searches to demonstrate as the considered model will impact in the fiscal and customs controls as well as in the improvement of the logistic flows.

The considered model is anchored in the lines of direction of security established by the Organização Municipal das Aduanas (OMA) through the SAFE Frameworks of Standards through the International Maritime Organization (IMO), through the International Code of Security and Protection the Ships and Port Installations (ISPS-Code), for the Government of the United States of America through Container Security Initiative (CSI) and of Safe Ports Act, for the Secretariat of the Brazilian Federal Prescription through the Plano Nacional de Segurança Aduaneira (PNSA) of Nota Fiscal Eletrônica (NFe) and Conhecimento de Trânsito Eletrônico (CTe) in set with the Secretarias de Fazenda Estaduais, as well as for the private sector who they come implemented initiatives directed to

the control and monitorial of load through systems of Management of Risk and the systems of Tracking and Electronic Sealing waxes applied to loads and vehicles.

For context effect, it will be presented the process of importation and exportation, its aspects of transport, load storage and manipulation, as well as a macro vision of the documentary flow and the intervening private public and involved in the process. To follow the proposals of regularization of the logistic process of chain will be presented insurance elaborated by Customs-Trade Partnership Against Terrorism (C-TPAT), Business Alliance will be Secure Commerce (BASC) and of the International Organization for Standardization (ISO) through the ISO 28000 and correlates.

The operational model that will be formulated consists of the proposal of an integrated logistic control. This boarding has for objective to present the diverse characteristics of the modal load flows and type, that is granary, container and general load. The implementation of this model will provide to an increase of productivity of the sector therefore the adoption of measures of load control demands that the planning of the logistic operations is effected, followed and corrected whenever necessary. In such a way the sector of logistic could use this tool for the increase of productivity and consequence reduction of the Custo Brasil.

The implementation model will be formulated supported in four pillars: regularization of processes, regularization of technology, formularization of a model of Acreditação of modal process and entities for and/or area of performance and the formularization of a model of continuous evaluation of level of service of the companies and

the process.

Finally, 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.

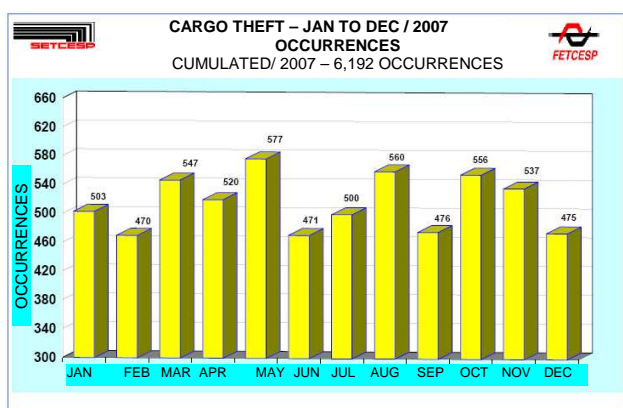


Figure 1 – Cargo Theft

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;

- ✓ 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;
- ✓ 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 chain 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.

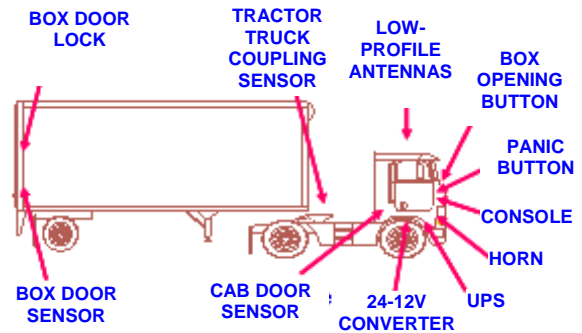


Figure 2 – Cargo Tracking
From Author.

3.2.4 Positioning Systems

Are systems that indicate the position of the vehicle or cargo. These systems differ in technology, accuracy, coverage and associated costs.

Signpost: is a system that provides the location of the vehicle or load from the indication of proximity to a reference point. The identification of the vehicle or load is done via a *transponder*, identified by reading stations (*signpost*) that transmit given location to a central processing. The *Signpost* has as main advantages, the cost of equipment onboard and their robustness, the disadvantage, the cost of the infrastructure of communication. There are two technologies applied in this form of location:

Passive systems - are devices with a low amount of information, typically store only the identification code of the vehicle or load that can not be updated dynamically. These embedded devices usually have no source of power and have low implementation

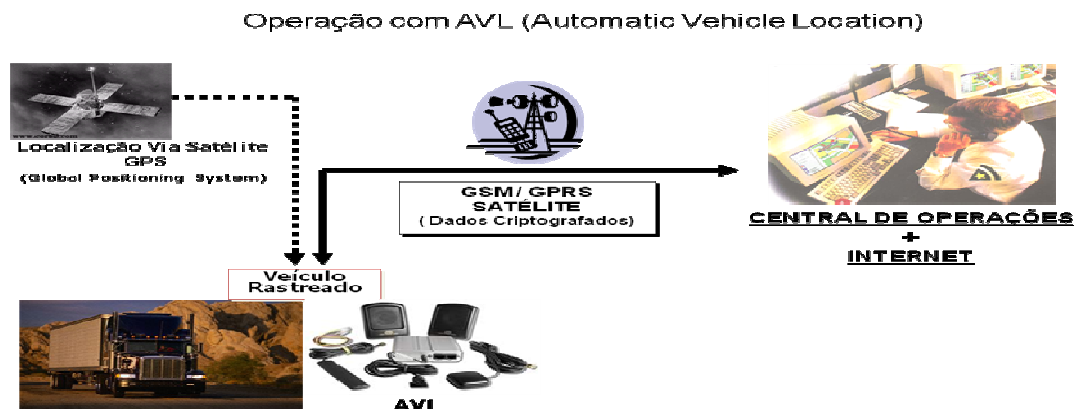


Figure 3: Automatic Vehicle Location Component - Source: From Author

cost.

2 - Active Systems - These systems use tags with power and allow the storage of information in a dynamic way, in other words, you can record information such as points of reading, number of passengers on board the device, during the process.

Radio Frequency: This system processes the position information from information acquired by terrestrial systems, bidirectional communication through a radio network with unique frequency. It consists of a network of radio antennas, a communication unit installed in the vehicle or charge and a processing unit. This system has as main advantages, the precision, using the same communications channel for finding and exchanging information between the central and the device and a greater availability on GPS (*Global Position System*) as the main disadvantage shows the cost of implantation of the antennas.

Mobile network: better known as LBS (*Location Based Services*), has its operation based on the use of the infrastructure of mobile telephony.

The main technologies used in this system are: **Cell ID (cell identification)**. This is the simplest method of location and also the least accurate, since it is based on information coming from the identification of the cell to which the user is connected, and these cells can vary in size from 500m to more than 10 km in rural zone.

Timing Advance: This method allows to establish the location from time spent in the signal path between the antenna and the device.

AOA (Angle of Arrival): from *the* angle of arrival of the signal from the device into two or more receiver antennas is calculated its position. The advantage lies in the simplicity of mobile devices and the disadvantage is the high cost of the infrastructure of antennas directional.

TOA (Time of Arrival) is the location method based in the time of arrival of the signal from the device to the receiving antenna. May be posted two main methods:

TDOA (Time Difference of Arrival): This method measures the arrival time of the signal transmitted by the mobile device to the equipment called LMU (*Location Measurement Units*). From a user's request, the base forces the device to transmit a request of time measuring that is processed by the central SMLU (*Serving Mobile Location*

Center), determining its location. The advantage of TDOA is the use of the existing base, but its performance will depend of network traffic.

E-OTD (Enhanced Observed Time Difference): This method also uses the calculation time of the signal between the device and antenna, but who does the calculation is the device. The location is determined by the signal processing of at least three antennas, located in neighboring cells. It is recommended for areas with high concentration (density) of antennas and requires adaptations in the devices.

GPS - Global Positioning System: is a global positioning system that uses a network of 24 satellites orbiting the Earth. These satellites send signals with accurate information from their position / elevation and time of departure of the signal at specific frequencies that are processed by devices allowing to calculate the specific location on the globe. The calculation is done by the device with the information from at least four satellites. Thus, from the information received from the satellite (position, elevation and time of arrival of the signal) is fixed the first radius of location; from the second are assigned an area of intersection and so on, until the attainment of the location by triangulation.

Its main advantage is its global coverage and low cost device. Its disadvantage is the influence of shadow zones such as mountains and signal interference, such as those in urban centers.

Hybrid Systems / A-GPS (Assisted GPS) are systems that combine the technologies of GPS and LBS and are recommended for large urban centers. In this system a station receives, handles and transmits the information received by the satellite via the cellular network, reducing the cost of the embedded device, because it reduces its processing. Another advantage is the possibility of combining other technologies such as "Cell ID" or triangulation of antennas, if the GPS signal is unavailable.

Figure 4 shows a comparative summary of positioning systems presented, with their main characteristics:

| <u>Método</u> | <u>Célula</u> | <u>Tempo de propagação</u> | | <u>GPS</u> | |
|------------------------------|--|--|--|---|---|
| | | <u>TDOA</u> | <u>E-OTD</u> | <u>GPS</u> | <u>A-GPS</u> |
| <u>Precisão urbana média</u> | 50 a 500m 500m a 10Km | 250m | 75m | 15 m | 5m |
| <u>Terminais especiais</u> | Não | Não | Sim | Sim | Sim |
| <u>Custo</u> | <u>Menor custo de implementação</u> | Necessidade de pesados investimentos na rede e em servidores | Necessidade de investimentos na rede, servidores e terminais | Necessidade de investimento em terminais | Necessidade de investimentos em terminais e processamento na rede |
| <u>Obs.</u> | Precisão dependente do tamanho da célula | Precisão vulnerável à carga de tráfego da rede | Dependente de grande densidade de estações | Não tem cobertura <i>indoor</i> e sofre severas limitações com <i>multipercursos</i> e obstáculos (prédios) | <u>Restrições à cobertura <i>indoor</i></u> |

Figure 4. Comparative summary of positioning systems.

Source: Technical report of the “Central de Operações e Vigilância” – COV (Central of Operations and Surveillance – Plano Nacional de Segurança Aduaneira da Secretaria da Receita Federal.

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.



Figure 5: Large Stationary System
Source: From author



Figure 6: Scanner
Source: EBCO SYSTEM LTDA

The triplet: Penetration, Spatial Resolution and Flow

To better understand the functioning of an equipment of non-intrusive inspection, you can compare it with the mode of actions of the human eye.

For example, in a dark place, lit by a stroboscopic light, the identification of objects is done through the shadows on the wall opposite the light. If the object is very thin, the relation that as higher the energy as better the identification of the object may not be true.

Likewise, the amount of energy released by the x-ray device is not indicative of any object crossed by it will be seen in the radiosopic image.

Therefore, is necessary to concern which is the adequate amount of energy to observe specific material. In the human case, the eye is the instrument that captures the signal and generates the image, in the case of the non-intrusive inspection equipment, the diodes have this function, with the advantage that there are several types that can be used, depending of the target.

Besides the intensity, if the light flashes at a too fast frequency, the eye may not recover in time and if the object passes very fast, it will not be seen. Similar results were obtained with the non-intrusive inspection equipment, where the diodes have the function of capturing x-rays; if the chosen diode were not appropriate, failures in the distinction of details can be happens. Therefore, the diodes must be developed to recover its capacity to act in a compatible time with the speed of the object.

The non-intrusive inspection equipment, as well as the human eye, have affected his performance due to several factors, that cannot be treated separately. The main factors that should be considered in a non-intrusive equipment: penetration, resolution and flux. The penetration is linked to the observation of objects, the resolution to image quality and the flow speed of processing.

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 radiosopic 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:

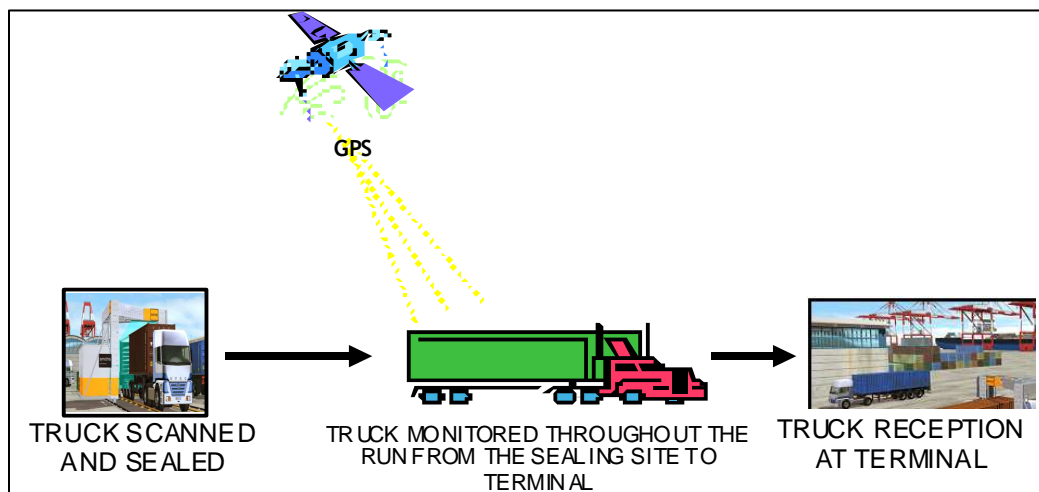


Figure 7: Tracking

- ✓ 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;

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