

# **ITS TECHNOLOGY FOR INTERMODAL PORT APPLICATIONS**

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## **ABSTRACT**

The world is shifting to a global economy, which is resulting in increased world trade, increased seaborne trade, and increased use of intermodal transportation. The increase in trade is putting pressure on freight transfer points or ports to handle larger volumes of cargo, in a more efficient and reliable manner, and at a lower cost. Also, national ports of entry (POE) must operate in an efficient and cost effective manner while satisfying needs of increased security. Recent international events related to the question of security and public safety will cause POE's at national borders to review their operations with attention to inspection, documentation including contents and origin, carrier, logs and other national security concerns.

This paper investigates different types of intelligent transportation systems (ITS) that are being deployed at transfer points and domestic ports and POE's across North America to address the needs for greater efficiency, lower costs, and increased security. In particular, this study focuses on the potential benefits that port authorities can expect to receive with the implementation of various ITS technologies related to motor carrier activities and cargo, and their interaction with port facilities. The importance of ITS technologies are the benefits they provide to improve truck routing information in order to optimize traffic flow in and out of the port, and through the port property to the loading / unloading points and cargo documentation.

This paper examines ITS technologies and systems such as global positioning systems, identification technologies, weigh-in-motion and preclearance systems and highlights the potential capabilities and applications of each system to improve intermodal port issues such as commercial vehicle congestion and operations inefficiencies.

## INTRODUCTION

The efficient movement of freight is essential to a strong economy. In the last 25 years, North America has moved to an increasingly global economy. Imports and Exports comprise approximately 20 percent of the gross domestic product and are expected to triple over the next 25 years (1). In addition, worldwide trade is also on the increase, with a large portion of this trade being done by sea. World seaborne trade has increased for 14 consecutive years and exceeds 5 billion tons per year (2).

In relation to the overall increase in trade, the volume of cargo through freight transfer points, generally known as ports is significantly growing in North America and around the world as globalization occurs. The number of intermodal containers moving through ports in the US doubled over the last decade, and intermodal air freight and the volume of intermodal freight moved by truck grew rapidly (3). Container traffic is expected to increase from the present level of 188 million TEUs (twenty-foot equivalent units) per year to between 417 and 491 TEUs by 2012 (4).

According to Dr. Satoshi Inoue, Secretary General of the International Association of Ports and Harbors, “The continuous progress of globalization of shipping and trade business is resulting in an increasing pressure on ports to reduce terminal cost and improve operational efficiency. Continued efforts are simultaneously needed to provide better terminal services with lower cost.”(4) This must be accomplished through operations that do not compromise security, and will need to accommodate increasing security measures expected to be mandated after recent world events. If intermodal ports are to compete effectively in international markets, while providing improved security, port facilities must look at intelligent transportation systems (ITS) technologies to support an efficient transportation system. ITS technology can be used to increase tracking and monitoring of cargo records, vehicle activity, and personal activity, and to minimize congestion and harmonize operations.

Intelligent transportation systems are transforming the intermodal freight industry by enabling it to integrate operations. Advanced communication and information systems provide real-time information on intermodal freight operations and congestion on the physical transportation system. This can enable port authorities to optimize the port efficiency such as truck congestion, availability of trucks, on-time delivery and traffic control. In addition, ITS technology can help security by providing cargo and carrier data, access control and tracking of cargo and hazardous materials. Finally, the incorporation of weight screening can offer the port authority real-time information to confirm documentation, help to alert authorities of undeclared cargo and identify overweight containers that could damage the port facilities, the cargo ship or highway infrastructure if the container is allowed to proceed. Further, weigh-in-motion ensures that outgoing shipments are not delayed further down the road at an inspection station.

By incorporating ITS systems and programs into existing intermodal port facilities, port facilities can look to enhance the security, safety, reliability and responsiveness of the intermodal freight systems, as well as the national transportation system.

## INTERMODAL FREIGHT TRANSPORTATION ISSUES

Terminals are the interface points in the intermodal system, where freight, equipment, and information are transferred from one mode to the next. Terminals include maritime ports at which freight is transferred to and from trucks, which is the main focus of this paper. Terminals are typically the entrance point of imports and have a customs or national security responsibility as well. Although these are vital activities, their traditional mode of operations can often hinder the smooth transfer of cargo. At times, cargo can be delayed for days for lack of clearance or problems in communication between the numerous parties involved in the shipment.

An example of the typical truck-marine intermodal freight movement begins with the shipper or consignor, who loads the cargo into a container. A motor carrier picks up the container from the shipper and transports it to a seaport where the container is transferred to an ocean carrier. The ocean carrier transports the container to an overseas port, where the container is transferred to a second motor carrier, who delivers it to the receiver or consignee

There are numerous issues surrounding the efficiency of intermodal port operations including the following (5):

- a) Lack of Adequate Structure – For example shortage of new loading and unloading equipment; poor land access, including larger capacity and better designed access roads, bridge improvements to assure adequate clearances and weight capacities for truck and double-stack rail.
- b) Congestion – Congestion occurs on access routes, bridges and tunnels servicing intermodal port terminals located in large urban areas. Delay on access and major trucking routes increases costs and adversely affects the ability to provide reliable just-in-time service. Throughout the process of transferring cargo from truck to marine, effective road access to intermodal terminals was cited as “the number one problem” impeding efficiency according to a report conducted by National Commission of Intermodal Transportation in the United States (6)
- c) Operational inefficiencies – There is a need for better located rail freight routes, and extension of double-stack rail service; the need for new facilities for managing and tracking shipments, pre-clearance, scheduling equipment usage, and managing fast and efficient flows of full and empty containers; and the need for better management of intermodal operations and improved coordination among modes.
- d) Improve visibility – There is a need for better tracking and awareness of shipment status for shippers, receivers, and transportation companies.
- e) Security – Customs officials require loading documentation including contents, destination, value, etc. and require tools and processes to alert agents of potential problems including smuggling operations, the importation of restricted cargo such as weapons, certain agricultural goods, refugees and other restricted practices. Automated route information, source data, carrier registration, container weight and other information relevant to the duties of customs officials will help improve security and the inspection process.

# **ITS TECHNOLOGY FOR INTERMODAL PORTS**

There are many issues involved when improving the efficiency and operation of intermodal port facilities including regulatory issues, customs, national security, public safety, jurisdictional issues, interoperability and standardization, and information sharing. This paper will focus on specific ITS technology that can be implemented to improve port operations, particularly the interface between commercial vehicle operations and sea shipping, while acknowledging that other issues do exist and will need to be addressed. Congestion at the port is the greatest challenge as congestion and delays cost the economy in productivity and ultimately affect Gross Domestic Product (GDP). Further, congestion can cause undue stress for shippers and operators, and could sacrifice security processes.

To help mitigate congestion, improve efficiency, and increase security at intermodal port facilities, several ITS technologies can be used in intermodal port applications:

- a) Global Positioning System
- b) Identification Technology
- c) Weigh-in-Motion Technology
- d) Preclearance Systems

## **GLOBAL POSITIONING SYSTEM**

The commercial vehicle can be equipped with automatic vehicle location (AVL) systems, which can provide vehicle tracking by the use of Global Positioning System (GPS). AVL can also be used to improve fleet management and logistics within an intermodal port facility. For years, individual trucking companies have been using AVL to streamline operations in order to meet the demands of the consumer. With the use of AVL and a vehicle control center the following services could be provided within a port facility and the surrounding transportation network:

- Obtain information on a specific vehicles location and other information on fleet operators, including anticipated arrival time.
- Monitor movement for security purposes to make sure that once a container is in transit, it is not delayed and does not go off route, where tampering can occur.
- Facilitates the use of dynamic dispatching systems to improve the efficiency of the fleet management process with the intermodal port facility.
- Relay information such as pre-trip information, and intermodal terminal condition to specific carriers.
- Provide individual vehicles with optimal route options for a specified destination, based on real-time network status.
- Optimal trip planning for specified cargo within and out of the port facility.

Given the capabilities of AVL, there a number of problems that can be potentially streamlined with the implementation of AVL:

- a) Visibility for tracking progress – The ability to determine the location of a particular container as it moves through the transportation chain.
- b) Schedule upcoming activities – Better utilization of the fleet using the real-time communications and planning, based on needs and available vehicles at or near the port.

- c) Efficient dispatch – Routing and rerouting trucks in real-time based on needs, location, traffic conditions, port congestion, and other factors.
- d) Haz-mat, special loads control – Cargo tracking can be particularly important for valuable or hazardous goods to ensure they follow the correct route and reach their destination. Loosing or mishandling certain cargo could result in a financial or environmental catastrophe.

## **IDENTIFICATION TECHNOLOGY**

Global transportation and logistics are rapidly being transformed by the ability to use communication technology to identify and monitor cargo and equipment in real-time virtually anywhere in the world. These technologies have been applied to both line haul and to intermodal transfer operations. With the use of electronic cargo tags and mobile readers, terminals can manage traffic flow through gates and track yard equipment for improved cycle time and productivity.

More specifically vehicle, container and cargo electronic identification has the capability to improve the following capabilities within the port:

- a) Security, access control, access automation – Current electronic identification tags have the capability to read/write or send information. These tags can be used as part of gate transactions to identify the driver, company and cargo and ensure that only authorized access is given.
- b) Location and movement tracking – These technologies can be used for location determination and navigation of vehicles and cargo within the port facility.
- c) Cargo monitoring and identification – Among the vast number of containers within the port facilities, obtaining accurate load information can increase the efficiency within the port facility. Information can be based on simply identifying the container and relating this to known information, storing a container contents inventory on a tag, or active monitoring and recording of container temperature, weight, orientation, impact, or other factors for sensitive cargo. The times at which a container is open and closed could also be recorded, which could identify changes in cargo or tampering between departure and arrival.
- d) Preclearance systems – Identification technology for cargo and vehicle tracking can also be a component of a preclearance system. Vehicles that meet specific criteria are identified by the electronic tag and have preclearance to access the terminal, bypass inspection stations enroute, and cross borders, thus saving valuable time.

## **WEIGH-IN-MOTION**

Weigh-in-motion technology has been used in a number of transportation applications such as weigh station preclearance, commercial safety systems, data collection systems, etc. WIM can be combined with other ITS technologies to obtain real-time information on a specific vehicle such as weight, dimensions, speed, etc. This information can be used to track, regulate or enforce specific policies for any given intermodal port facility.

WIM can also be used to streamline and enhance a number of requirements at an intermodal port facility:

- a) Automate vehicle compliance checks within a port – WIM can be used in a similar fashion as it is used for weigh stations, where it is used to obtain specific vehicle information (weight, length, height, axle spacing, etc.) in order to compare with the bills of lading and governing regulations. More specifically, WIM can be used in port facilities for compliance checks for the following reasons:
  - i.) Identify discrepancies between registered cargo and actual cargo to identify documentation mistakes or deliberate attempts to smuggle or misrepresent cargo. Containers and cargo documentation provide content and weight information. Weigh-In-Motion can alert authorities of suspected shipments.
  - ii.) Safety – To monitor the weight of incoming trucks and containers and identify potentially overloaded containers that could lead to damage or failure of loading and transfer equipment, and unbalanced loading or over loading of vessels.
  - iii.) Preservation – Commercial vehicle weights and dimension laws are enforced by highway agencies to ensure that excessive damage is not imposed on the highway infrastructure. However, many short haul carriers using the port facility may not pass inspection stations and operate with no checks on their weight compliance. Overweight vehicles lead to increased damage to port access roads and port facilities, as well as a bad public image about the operation of the port.
- b) Limit delays at inspection stations – Overweight vehicles leaving the port are more likely to be stopped and detained at inspection facilities, which can affect the on-time delivery of cargo. WIM can be used to perform a pre-trip compliance check prior to leaving the port, reducing the likelihood of delay down the road.
- c) Preclearance systems – WIM can be used to gather specific vehicle information in a preclearance system, as described in the following section.

## **PRECLEARANCE SYSTEMS**

Public sector regulation of trucks for weight control, licensing and permits cause delays for commercial vehicles, which increases the cost of delivering goods. ITS applications for intermodal port authorities are aimed at minimizing these unnecessary stops and achieving an improvement in logistics for the intermodal port, as well as commercial vehicles within the ports operational region. As freight distribution becomes more centralized and the practice of just-in-time deliveries spread, so does the value of intelligent checking and dispatch systems. The electronic processing of associated office work, provisions of information on routes where passage is requested, and information on the actual passage route chosen by commercial vehicles all assist the operator to manage loads more efficiently. In addition, preclearance systems can:

- a) Minimize delays for compliant carriers – Weigh station checks and roadside inspections, especially when there is congestion, create a burden for compliant motor carriers by creating additional delays.
- b) Address non-compliance issues in advance – Terminal gate clearance systems could be linked to state motor carriers safety systems to provide drivers and terminal operators with a pre-travel check of the regulatory status of the driver, vehicle and motor carrier firm, as well as a weight check using WIM. With this information, problems with

credentials and equipment could be addressed before a driver leaves or while in transit to the inspection facility, reducing the likelihood of delays from inspection en route.

- c) Maintain transportation infrastructure – Preclearance systems provide better protection of the highway infrastructure through more efficient and effective enforcement. The result is longer lasting and higher quality roads, with fewer delays due to maintenance and construction activity.
- d) Additional tracking points – Preclearance systems can also provide tracking information that can be used as advance information to prepare for the arrival of the vehicle at a port or border crossing facility, or for locating the vehicle and updating the status of the cargo movement.
- e) Shared information – Preclearance systems can provide input into a shared information system that could include ports, border crossings, inspection stations, and other regulatory agencies. Checking of a vehicle for compliance at an inspection station can provide necessary valuable information that can be used for processing the vehicle at other locations within the transportation system.

Commercial vehicle operation technologies include (a) automatic vehicle identification to allow truckers with all the required permits to bypass checkpoints at specific points within the port facilities, (b) weigh-in-motion scales to screen vehicle so that legally loaded trucks do not have to stop at static scale inspection points, (c) electronic cards to identify specific vehicles and drivers, and (d) automatic collection of fees/ tolls. All of these ITS technologies can be used to optimize intermodal port facilities through electronic processing of information and preclearance of commercial vehicles.

## **TECHNOLOGY IMPLEMENTATION**

The above ITS technologies should not be considered as a “silver bullet” for effective operations of intermodal port authorities. The above ITS technologies are complimentary, and a mixture and planned approach will offer an efficient and cost effective program. It is critical to study the unique aspects of each port facility, and to design a system and method to best suit the circumstances. Issues that must be considered in this design include:

- Technical interoperability – Interoperability of ITS technology is preferred, so that each commercial vehicle or cargo container does not have to carry more than one common system. This will also ensure that the data (safety, cargo, etc.) can be used by regulatory agencies in every region traveled by the vehicle or container. Interoperability can save a great deal of time and expense. However, agreements between various organizations must satisfy both technical and institutional conditions.
- Cooperation among multiple agencies – ITS technologies support paperless transactions for many functions – regulatory, safety, taxation, customs, etc. Thus, full ITS implementation requires the cooperation among many public agencies. The intermodal port authority considering ITS applications should be prepared to work with public agencies outside of its normal organizational relationships.
- Specific statutes on commercial vehicle permits and authorization. Commercial vehicle operations can be quite different in different countries due to their geographical and regulatory contexts. Arrangements for commercial vehicle permits and authorities vary from country to country and from region to region.

- Containers and cargo documentation provide content and weight information. Weigh-In-Motion can alert authorities of suspected shipments.

## **SUMMARY AND CONCLUSION**

Shipper's transportation requirements have changed in response to increasing security needs, cargo volume, and competition. Shippers have pressed for cost reductions and service improvements. Shipper's requirements include frequent, reliable, and fast service; dedicated equipment; full logistics services including cargo tracking, just-in-time inventory management, warehousing and distribution; and the ability to exchange information electronically to handle bookings, cargo status, billing and other data interchange. Regulators are tasked with facilitating smooth and seamless movement of goods, while meeting increasing requirements for monitoring, control and inspection of freight.

The transportation industry's response to these shipping requirements has resulted in higher quality value-added service. Advanced technology has revolutionized transportation. Transportation service providers widely use advanced technologies to identify and track cargo and equipment in real time and to transact business electronically. Industry has adopted technology solutions to solve specific business problems. An investment in ITS systems can further improve the productivity and safety of intermodal freight operations.

ITS implementation can reduce operating costs and allows productivity improvements. While cost reduction is of interest to all road users, the associated benefits are most tangible to intermodal port authorities and commercial vehicle fleets. In the global marketplace, the port that can best meet the shipper requirements will have a competitive advantage, leading to increased volume and profitability. This competitive advantage will also have a positive impact on the surrounding region and the host nation, by providing trade advantages leading to increased economic development and prosperity.

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