

BULLETIN

FAL

FACILITATION OF TRANSPORT AND TRADE IN LATIN AMERICA AND THE CARIBBEAN

# Intelligent transport systems in Latin American sea port logistics

## Introduction

Sustained growth of international traffic is putting enormous pressure on port terminals to speed up operations, keep charges competitive, and offer value-added services. These trends demand more and better investment in port infrastructure and their links inland, along with technological innovation to boost the productivity of existing infrastructure.

Intelligent transport systems (ITS) are primarily associated with freight, vehicle and infrastructure operations, where they are well known and a wide range of research and applications exist. Their use in ports, particularly to facilitate co-modal transport, is less familiar, despite the fact that their ongoing, coordinated use can improve productivity and security, and make logistics more efficient, competitive and sustainable.

This newsletter reviews the main concepts and presents some applications in Latin America, which have reinforced the sea port as an intermodal node.

## I. Sea ports and intermodal nodes

By definition, a sea port is an intermodal node linking international with domestic transport. In Latin America and the Caribbean, this involves connecting high-technology maritime transport with ground transport that tends to be fragmented, relying on obsolete equipment and tariffs that allow mere subsistence, insufficient for investing in better services and technology. This mismatch poses an enormous challenge to sector

This issue of the *FAL* bulletin analyses the role of intelligent transport systems (ITS) in sea port logistics in Latin America. This work forms part of Unit activities within the "Sustainable Transport in Ibero-America project", financed by *Puertos del Estado, España*.

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officials, since port competitiveness increasingly depends on links to the hinterland and logistical services on offer. Aside from resolving infrastructure issues, then, the port-ground transport connection requires improvement, which should start with building suitable cooperation among participants at each link of the logistics chain, then establish shared goals, and a clear analysis of challenges and problems, to define where new technologies can contribute the most.

In their efforts to boost country competitiveness, public and private actors tend to focus on infrastructure, boosting productivity, reducing port charges, and improving customs and trade-friendly systems, without analysing intrinsic transport problems —where many logistics-related cost overruns occur. In this sense, for ITS to make freight traceable and port services and infrastructure in Latin America and the Caribbean more productive and competitive, institutional barriers and public-private coordination should be organized appropriately within each sector.

## II. ITS for more sustainable, competitive ports

As a result of profound shifts in both the global economy and merchandise production and distribution, today international logistics require synchronizing multiple actors and real-time feedback to better coordinate production and value-added services. Given prevailing conditions in Latin America and the Caribbean, it is hard to make infrastructure grow apace with demand, so getting the most out of existing facilities is essential.

Today’s clients demand lower costs, but also faster, more reliable and complete services, including full traceability

of goods (not only port-to-port, but door-to-door), online inventory management, distribution, billing and customs procedures, among others. In this context, using ITS and other information and communications technologies (ICTs) forges an increasingly extensive, complex logistics chain, improving competitiveness and optimizing infrastructure, as discussed in the following sections.

ITS systems combine and coordinate different data processing, transmission and control technologies to boost transport efficiency, security and sustainability. They capture, process and transmit information regarding freight, traffic and vehicle operating variables, and thereby improve human resource and equipment management. Freight traceability, for example, makes possible value-added services and complex just-in-time logistics, cutting down on excess travel and wait-times on highways and at terminal access points, and improving energy efficiency and security, while trimming transport emissions to reduce both operating costs and negative externalities (social and environmental).

The region’s systematic and planned integration of ITS should apply the same technological platform throughout the logistics chain, including railways and highways, to optimize transport operations and offer ongoing responses to changing market requirements.

## III. The main ITS systems serving ports

A range of ITS equipment exists for handling freight. Table 1 provides basic categories, revealing that different systems can use the same technology and support diverse applications.

**Table 1**  
ITS systems used in ports

Need	Medium	Objective	Its technology
freight traceability / security	Freight	Security	Electronic seals, tampering
		Freight quality	Temperature, humidity, vibration sensors
		Dangerous freight	Electronic Identification Fleet management systems
	Transport mode	Mechanical condition monitoring	Sensors: fuel level, tyre status, speed, mechanical alerts.
	Infrastructure	Monitoring traffic conditions Weather conditions	Traffic management systems Weather stations monitoring rain, fog, precipitation, atmospheric pressure, etc.
	Driver	Identification Route conditions Driving times	Automated identification systems Traveller information systems Fleet management systems
Equipment (cranes, trailers, other)	Depending on type of freight	Automated identification systems	

Table 1 (concluded)

Need	Medium	Objective	Its technology
Infrastructure efficiency	Tolls	Free-flow	Electronic payment
	Weigh station	Non-stop	Non-stop weighing
	Port terminal access	Shorter stops	Automated identification systems
	Border crossings, customs procedures	Shorter stops Less paperwork	Automated identification systems
			One-stop counter
			Electronic bill of lading
	Terminal logistics management	Efficient use of space and resources Reduced operating costs	Terminal operating systems
			Automated identification systems Automated machine guidance
	Inspection	Selective Freight verification	Automated identification systems
			Image processing systems
Planning	Reliable information	Fleet management systems	
Operations	Real-time information	Terminal	
		Electronic data transmission	
		Port community systems	
Trade	Electronic	Electronic data transmission Port community systems	

Source: Prepared by the authors.

## IV. ITS applications in Latin American ports

The next section reviews a set of ITS applications used in Latin American ports. This is not a complete list but rather provides examples from experience in the region. Similarly, while applications such as container scanning and security monitoring systems reflect significant progress, their use is widespread throughout most of the region, so these are not discussed in detail here.

### 1. Port ITS and productivity

Terminal management systems focus on optimizing maritime freight processes, loading and unloading of ships, and logistics planning, including operations and localization, human resources, equipment and warehousing.

Systems integrating international trade, public agencies and transporters are referred to as port community systems (PCS). For each transport mode using the port, these optimize entry and exit traffic, identifying and establishing working priorities for equipment, personnel and localization, and thereby optimizing infrastructure and available space, to trim operating costs.

Most of these systems are expanding to include the whole logistics chain, adding electronic data interchange (EDI) to share standardized information more easily, reduce processing and inspection times in terminals,

improve data accuracy, improve storage yard and vehicle efficiency, and reduce paperwork.

These ITS applications include:

- Optimization of traffic programming for all transport modes;
- Identifying and setting priorities for work orders;
- Planning and optimizing storage, personnel movements, terminal equipment and infrastructure use, inventory and inspection;
- Transport reserve and dispatch systems, to assign freight time and location;
- Providing freight trucks with intelligent access and automated guidance into reserve areas;
- Automated electronic readers to locate and register positioning in storage yards;
- Computer-assisted assignment policies for parking lots.

There are many examples of implementation throughout the region, using proprietary (associated with a single supplier) and open-source systems. These use information technologies to distribute the port's available space more effectively, thereby optimising operations. The port of Valparaiso (Chile), for example, has designed a management model that grants a concession to a single, private technology operator, who develops, administers



and operates a single platform to coordinate information exchange among all public and private bodies involved in imports and exports through the port, speeding up paperwork, and saving time and money. This system also supports a selective freight operation model in real port time, which has pushed terminal productivity much higher than the traditional first in first out (FIFO) approach.

## 2. Traceability throughout the logistics chain

Latin America has invested significantly in technologies to improve tracking (real-time location) and traceability (being able to follow the whole route taken by a specific item in non-real time, sometimes referred to as 'flow memory') throughout the logistics chain, which is fundamental to ensuring transport competitiveness and sustainability. This is a welcome trend, reflecting significant progress, but many firms have done so only to control theft, rather than as a general tool to improve fleet management and add services. For a growing number of economic actors, including retail and production sectors with higher purchasing power, when choosing a transport firm, security and on-time delivery are more important than price or delivery speed. To meet these requirements and thus gain access to more valuable contracts and better working conditions, companies should be well structured and trained in real-time fleet management. This makes traceability and other ITS essential, as they offer the following social and environmental benefits:

1. **They make it possible to provide integrated logistics services**, by providing the technological support necessary for complex just-in-time systems, which require reliable, up-to-date information for stock management and the entire transport chain. This favours co-modal transport, reducing costs and making multimodal logistics platforms feasible.
2. **They help cut carbon emissions and other transport-generated pollution**: making transport management responsive to prevailing demand and traffic conditions can cut delivery travel time and fuel use, reducing pollution, congestion and energy consumption. These are all particularly important to businesses increasingly concerned about their carbon footprint, offering suppliers a competitive edge.

3. **They reduce company operating costs**: primarily through reduced fuel consumption and thus greater energy efficiency. Savings just from monitoring assigned routes are estimated at about 4%. Reducing time lost during loading/unloading and empty-return trips can enhance these benefits. When combined with other ITS solutions, fleet management can also improve and make more evident driving hours, offer real-time information, and be useful in the event of accident or breakdowns en route, which also involve social benefits.

Many Latin American ports have implemented traceability solutions based on radio frequency identification (RFID). This involves an electronic tag, which sends radio signals to an interrogating antenna. Tags may provide identification only, using a unique code, or read/write data. At the Argentine port, Ingeniero White, in Buenos Aires province, for example, Cargill's has a cereal export terminal, storage silos and a malt factory. The recent rise in cereal production saw a significant jump in the number of trucks backing up around the port. This led to creation of a truck reception and quality control area (ACC), 10 km from the port. In this case, the port used UHF RFID systems which are readable at four to six metres from tags on trucks and trailers passing antennae at up to 20 km/hr. Two antenna-equipped recording positions and reading portals provided online information to Cargill's unloading software for use of RFID data in production and certification of grain quality, and peak times in ACC-destination (port or silo area) trips. Today, RFID monitoring is being expanded to cover the Bahía Blanca port and unloading wagons from other operating centres.

In Colombia, the national association of highway freight transportation, Asecarga (Asociación nacional de empresas transportadoras de carga por carretera), the transporters' federation Colfecar (Federación Colombiana de Transportadores de Carga por Carretera) and the Colombian infrastructure association (Cámara Colombiana de infraestructura) are considering an RFID-based transport visibility approach (*Iniciativa para la Visibilidad del Transporte Mediante RFID*), to identify freight and passenger vehicles using an RFID tag, so they can monitor key en-route locations, such as tolls, checkpoints, border crossings, duty-free zones, ports, etc. While this project will not replace satellite navigation systems, it will reveal the location of vehicles as they approach portals and permit traceability throughout the logistics chain, available online to owners and those working in ports, duty-free zones and logistical platforms. This will make processes more efficient and improve vehicle flow management at these locations.



Some ports, including Valparaiso (Chile) and Montevideo (Uruguay), have also used vehicle technologies such as electronic tolls. In Chile, the Televías system used for electronic tolls also traces freight throughout the logistics support area (*Zona de Extensión de Apoyo Logístico, ZEAL*) and travelling towards Valparaiso within an 11-km perimeter. The system will use four tag-reading portals to handle freight flows and security. Similarly, Montevideo uses tags to monitor cargo vehicles, although the system only monitors access to the port.

Key benefits, then, go beyond the port, for levels of traceability that improve ground freight transport efficiency, reduce wait times and increase truck productivity, by boosting capacity using the same equipment and personnel. This can also provide significant savings in fuel and emissions through greater energy efficiency.

### 3. Automated guidance systems

Automated guidance systems run vehicles using remote control. They involve the vehicle, the navigation and route selection system, and automated controls (including a system that monitors movement, inventory and vehicle status, an obstacle detection system and suitable interfaces with other terminal operations systems). These systems move and stack containers, using an onboard computer connected by wireless to the control centre in order to manage vehicle routes in the terminal, thereby keeping operations involving many containers constant and flexible, at lower costs.

## V. Port ITS and security

Since 9/11, port security regulations have steadily tightened, as authorities try to balance security and international trade requirements. Signed by the President of the United States in 2006, the “safe port act” (Security and Accountability for Every Port Act), for example, establishes minimum security requirements for all containers entering United States ports. Since 15 October 2008, all tow-trucks, containers and wagons in transit or with a final destination in the United States, require an International Organization for Standardization ISO/PAS 17712 mechanical freight container seal. Most of the region’s main ports have therefore implemented or are implementing security systems and container scanning and seals to ensure freight integrity after port inspection.

### 1. Non-intrusive scanners

This freight inspection system does not require opening the container, thereby reducing inspection times and improving economic efficiency by speeding up port operations, requiring fewer inspectors and cutting merchandise loss. Two methods are used: x-rays and radioactive inspection.

X-ray inspection systems produce clear images of containers, including the shape and density of contents. Radioactive systems use gamma rays and neutrons to detect nuclear material. These involve radiation portal monitors (RPM), which are large, plaque-like sensors that detect explosives, chemicals and nuclear materials. The high-sensitivity RPM, which can scan vehicles moving at up to 8 km/h, provides quicker, more effective inspections than the x-rays used today, finding 100% of radioactive material at a lower radiation dose to operators.

### 2. Container Security Seals

The main ISO certification requirement is for strong, long-lasting seals which can withstand an accidental break or damage (from weather or chemicals during handling), be easily and quickly removed with the right tools, and leave visible signs if there is tampering. They must include a highly legible identification mark and unique number, with any tampering (physical or chemical) producing the irreversible destruction of the seal. The electronics industry has provided many products, among them:

- Electronic seals: placed on container loading doors, where a cable is linked to fixed points on the door and a unique code is generated upon sealing. If the door opens, the code changes, thus generating evidence of tampering;
- High-security seals: made of resistant materials such as metal or steel wire cable, these both slow tampering and leave evidence of any unauthorized attempt at opening the container. These seals involve laser-generated consecutive numbering;
- Remote-control seal: this equipment adds a GPS receiver and GSM (Global System for Mobile Communications) transmitter, which send a locational message to the control centre in the event of tampering;
- Seal with sensors: the industry is adding sensors to monitor not only tampering with seals, but also light, temperature, humidity, vibration, and blows, to allow remote monitoring of freight security.

Working with the ports of New Jersey and New York, the Santos port (Brazil) is implementing a pilot project using radio frequencies to monitor coffee containers. This is part of its “safe trade operation”, which aims to improve the security of container transport arriving in the United States. RFID technology placed on containers in Santos monitors coffee freights from the moment the container is loaded until it reaches the United States, guaranteeing security and speeding dispatch to the country’s ports.

Several Latin America ports are implementing Vessel Traffic Service to improve maritime traffic security and efficiency and protect the environment. Generally, this consists of two or more remote radar sites, which provide precise real-time locations throughout the port zone, covering the access channel, internal anchorage, single buoy moorings and wharves. This information is processed, evaluated and distributed to identify and monitor the mooring and launching of each ship, and provides information about its characteristics and declared freight. This makes it possible to prepare for any detours or shifts in tidal or weather conditions, and to manage incidents within the assigned jurisdiction. Bahía Blanca in particular has implemented an open-source VTS system, which is not tied to a single technology supplier, which makes it easier to add new developments, in response to future demands.

The maritime traffic control centre (CTM) at Manzanillo port includes similar functions, but also exchanges information with other government bodies to monitor maritime traffic in the zone of influence, optimize flows to keep the port operating more smoothly and generate maritime, port and weather statistics. Guayaquil's Port Authority (Ecuador) is currently implementing an automated identification system (AIS) to provide exact data about ships, their trajectories, type of freight, position, speed, destination, and to see them on a monitor. This will help to improve safety, prevent collisions and improve traffic management, while saving time and costs in communications with ships, previously done by telephone and radio.

### 3. Access security systems

Most Latin American ports have implemented security systems covering their terminal yards and entrances. Integrated video intelligence systems connecting cameras at critical locations to control rooms, where images are processed and analysed to prevent, detect and monitor criminal or terrorist actions on port premises, are the most common. The company running the Buenaventura port (Colombia) uses biometric security to control port entrances.

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## VI. The need to coordinate public-private activities

To make the most of ITS benefits today and tomorrow, systems must be interchangeable throughout the logistics chain. The institutional framework that defines suitable ITS development and implementation through standards and basic technological definitions is referred to as the ITS architecture.

A national ITS architecture, then, should identify and define standards for present and future systems in order

to ensure the exchange of information, interoperability, lower development costs and less uncertainty about technological change. In practical terms, this requires four basic definitions about:

1. ITS applications or services, focusing mainly on different types of transport system users;
2. Functions and basic processes that ITS systems should control within infrastructures;
3. Guidelines about which technologies are most appropriate for the current state of the art, to ensure that ITS systems and equipment fulfil objectives;
4. Specifications for norms and standards for both equipment and systems to ensure compatibility, interoperability and consistency with national or international regulations, along with other generally accepted recommendations from professional or industry bodies for each of the technologies covered.

ITS architecture, then, does not refer to system design, but rather offers technical guidance for innovation and implementation of public-private solutions that will improve transport sector competitiveness and sustainability. This is why it is important for countries to define and regulate their own ITS architecture, giving priority to open solutions over proprietary versions (those associated with a single technological provider), since this ensures system sustainability and that benefits bring greater competitiveness. The essential architecture should define:

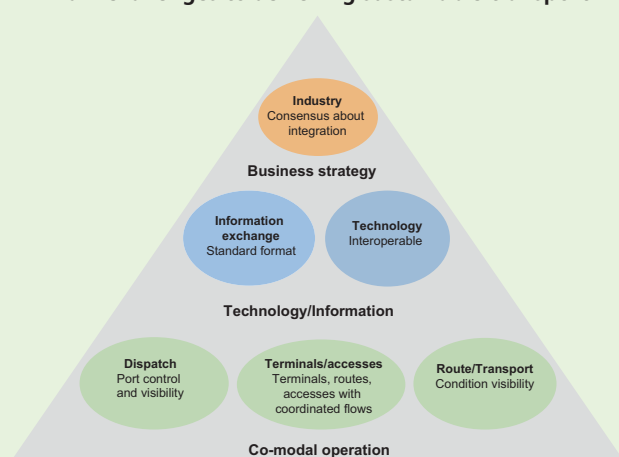
- Compatibility and connectivity of networks, systems and equipment that currently or eventually form part of the national and ideally the regionwide ITS network, regardless of who is responsible, since the interconnectivity of logistical networks often does not distinguish between local, national and regional services and infrastructure;
- Interoperable ITS technologies, based on principles of standardization, open systems and a variety of suppliers, both nationally and regionally, to generate a market size that can reduce technology costs;
- Optimization of technical features, performance and ITS system costs. Cooperation among public and private agents involved in the transport ITS system issues.

Figure 1 identifies the main challenges involved in building ITS architecture:

- Develop national/regional architecture and standards for exchanging information. Public-private instances, able to dialogue and make decisions on these issues, are vital to ensure industry reliability and performance;

- Define and agree on different private business strategies to meet national or regional objectives for competitiveness. Intersectoral dialogue, transport sector associations and professional capacity are all essential. Otherwise, the transport sector's competitive, complex and fragmented vision, with each actor following different ideas about the business, culture and historical forms of operation, makes interconnection and cooperation among the different links in the logistics chain extremely difficult;
- Finally, the public-private model requires utmost cooperation for suitable investments in management systems and transport. Given the infrastructure deficit throughout the region and the limits it can place on future development, a more productive and sustainable approach to both existing and future investment in infrastructure is essential. For investment in ITS to work, it must be embedded in concrete and coordinated action by government, industry and transport service users. The technology alone will not resolve such problems as the lack of communication or real commitment by all parties, and could even aggravate some conflicts if lack of trust among participants is not resolved early in the process.

**Figure 1**  
Main challenges to achieving sustainable transport



Source: Prepared by the authors on the basis of United States Department of Transportation, "Challenges and Opportunities for an ITS/Intermodal Freight Program."

## VII. Conclusions

The challenges of cutting logistics costs and improving freight security call for more precise control over travel times, more secure trajectories, less time spent on administering security and control, and avoidance of unnecessary stops, all of which require technology, specifically ITS systems.

Thus, ITS are key to achieving port efficiency and sustainability. Their implementation and integration are thus becoming increasingly urgent, especially at the interfaces where merchandise is transferred, such as customs, ports and multimodal stations. Coordinating the different private and public initiatives, both at national and subregional levels, is fundamental to the orderly development of these systems. This is the only way to ensure that information is standardized, up to date and shared in real time between public and private sectors in Latin America. Ensuring the early adoption of technology by actors throughout the logistics chain will not only improve competitiveness at the national level, but will also optimize preparedness for new, more complex issues. One such issue is demand for low-carbon transport services, which requires limiting emissions by avoiding unnecessary trips and reducing lengthy wait-times on highways and at terminal entrances.

Finally, it is important to remember that technology alone makes no competitive difference. These gains are only achieved by developing services and applications for which customers are willing to pay. Just as it is essential to invest in better infrastructure and technology in the logistics chain, it is even more urgent to reinforce training and foster internal innovation, to discover and, in some cases, develop new applications based on the technology available, which can resolve concrete logistics problems affecting national distribution.