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THE USE OF GLOBAL POSITIONING SYSTEMS (GPS) IN THE RAILWAY SECTOR

Tracking and tracing in rail freight - Different technologies for different objectives

Note: The text reproduced in the attached document is the reprint from the June/July 2001 issue of the *"Rail International"*. The author, Pierre Reinhardt, is the Director of the UIC Freight Department

Tracking and tracing in rail freight

Different technologies for different objectives

Preamble: what exactly are we talking about?

In the strict sense of the term "tracking and tracing", means locating and following objects which are by definition mobile, as are vehicles used for transport as a general rule. Nowadays the term is sometimes used to describe other applications based on current technologies, in particular satellite technologies, such as marking fixed installations with balises. That said, this paper will only deal with matters pertaining to railway rolling stock used for freight transport, and by way of comparison boats and aircraft.

Growing information requirements

Up until relatively recently, information regarding the position of wagons was very fragmentary and furthermore was not disseminated in an organized, systematic fashion to those, working in railway companies or outside them, who might find it useful. That said by making a number of enquiries it was possible to know when a train had arrived at or left certain special points on the network (stations of departure and arrival, border points, marshalling yards, etc.) and it was also possible to check if a wagon was or was not included in a given train.

In most cases however, and in particular when it came to international transport operations, nothing was sure until the wagon actually arrived at its destination.

Today, a carrier's customers no longer accept that kind of uncertainty. One of the defining criteria of the quality they perceive is the information provided regarding the whereabouts of their load. The fact is that a "gap" in information from the transport chain causes disruption to production chains which these days depend on low stock levels (and therefore speedy and reliable "just-in-time" transport) and at the end of the day causes unacceptable extra costs to the shipper, who in any case is used to being highly demanding of road haulers, the railways' rivals.

In addition, sometimes delays, incidents or changes in customers' requirements make it necessary to re-direct goods to a different destination and that can only be done if they can be located.

To optimize railway operations an effective information system covering rolling stock, locomotives and wagons is also needed. To deploy rolling stock as efficiently and at the same time as economically as possible (a major cost factor), you need to know its location and status as near to real time as possible.

If you can monitor journeys in a reliable fashion, you can also fine-tune the schedules for maintaining and overhauling rolling stock (to reflect actual distance worked rather than the time elapsed).

A range of technical solutions

There are three main families of technical solutions at present: utilization of railway company information systems (as they stand or after adaptation), A VI (Automatic Vehicle Identification) and satellite positioning (for instance GPS - Global Positioning System).

Railway company information systems

Each railway company has its own information system, each with its own level of sophistication and computerization, to meet its operating needs and its customers' requirements. These information systems provide a range of details regarding the status of wagons (obtained when specific messages are sent when rolling stock passes certain special points on the network). These information systems are currently being overhauled on most railways as they are no longer entirely satisfactory given developments in the industry (Internet), the obsolescence of relatively old applications and the need to enhance the quality of data capture.

On the international scene, things are more complicated owing to the fact that all applications have historically been developed on national bases. Certain international systems (HERMES) have been set up, but in fact are little used.

Two avenues of research are currently being investigated:

- Development of a multilateral project called ISR (International Service Reliability), supporting dialogue between the information systems of the various railway companies, participating once some adaptations are made, and using a service provider which is independent of the companies involved, to deliver the chosen information to participants in a confidential manner.

- Development of more lightweight, specific "tracking and tracing" projects, by successively extending an application run by one railway company, as is the case of the RAIL TRACE project run by the Finnish Railways (VR).

Automatic Vehicle Identification (AVI)

The idea is that a wagon, equipped with one or more "transmitters", is recognized when it passes in front of fixed "receivers" installed on the ground. The information gathered must then be transmitted via an ad hoc telecommunications network to a specific information system.
The accuracy in locating a vehicle thus depends directly on the density of the "readers" installed in the field.

In addition to information on the position of the vehicle, other data can be transmitted, such as temperatures, impacts recorded, the status of the doors (closed or open), etc.

AVI is used on a large scale by the American and Chinese railways and in a selective fashion by a number of other railway companies, including ones in France, Switzerland, Spain, Belgium and Italy.

Satellite positioning

The only system widely used today is the Global Positioning System (GPS) of twenty-four satellites (for military use initially) which constantly transmit coded signals, enabling those who own GPS receivers to know their location at any time by reading the signals transmitted by four of the satellites.

The accuracy is in the region of 25 meters, provided the owners of the equipment do not decide to downgrade the system's capacity (as they initially did).

It should be noted that the Europeans plan to launch a similar network, called GALILEO, by 2008.

The main feature of GPS is that it involves no equipment on the ground; the only conditions for it to function in practice are a source of energy and an integrated telecommunications system (of the GSM type - Global System for Mobile Communications).

It is worth noting that to date, there is no large-scale application of GPS in the railway world.

N.B.: For information, it should be pointed out that there are other technologies, but that they will not be dealt with here as they are less pertinent to the railways at this point in time or because they are derivatives of the above-mentioned technologies: in particular, the ARGOS system, tracking and tracing using the GSM system (Global System for Mobile Communications), mixed systems with GPS on the locomotive plus train bus, etc.

Some examples of applications

AVI applications on the American railways

All the MR (Association of American Railroads) member railways have equipped their wagons with "tags" or A VI transmitters. That move has considerably enriched the information system, although the latter still relies on a large amount of manual input.

The functions of the resulting system as a whole are less focused on locating vehicles as such, and more on monitoring the wagon fleet. Thus the actual position of wagons is systematically compared with what it should theoretically be. In this way (acting in the event of a disparity), wagons that have come to a standstill, have diverged from their original route, or have no consignment note can be located. Tracking down lost consignments is also one of the system's functions.

As a rule, the customer is constantly aware of the situation of his load. For the railway company, transport planning and fleet management are improved and remedial action can be taken in real time (a wagon can for example be re-routed).
Clearly, in order to be efficient, the system relies on data capture accuracy close to 100%. All the information is available to authorized users on the Internet.

One can imagine a plethora of ancillary uses for AVI if the basic equipment is supplemented with additional measuring tools. By way of example: Union Pacific manages the re-fuelling of

locomotives by constantly monitoring their fuel levels and actual position and directing them to the most opportune filling station, thereby obviating the need to send tankers to far-flung locations.

The RAILTRACE application run by Finnish Railways (VR)

This application was originally developed by VR for national requirements, but with the aspiration of extending it to other countries in the short term: first to Russia, then to the rest of Europe. RAILTRACE is based on using a specific information system.

It is also a system working on the principle of "action in the event of disparity", based on a central database open to the railway companies and logistics firms concerned and accessible on the Internet.

The system includes consignment note and wagon information.

Norms and standards

AVI technology is dealt with in some draft leaflets (Leaflet 539-1 since 1996) set to be published in 2001.

There are no European standards on applying satellite technologies to the railways at present.

Performance and cost comparison

The option of using railway company information systems has to be studied separately. Tracking and tracing applications are only a sub-set of the range of such systems, and they are not very accurate.

The comparative advantages of AVI over GPS are the cost price (although the cost of GPS is falling at present), the fact that the receiver is independent in energy terms and that the technology has been tested on a large scale on major railway networks.

Conversely, GPS has the merit of providing continuous information and of being absolutely autonomous (not depending on installations on the ground belonging to infrastructure managers). GPS is well suited to intermodality and can be deployed extremely rapidly and flexibly.

Expected technological developments

Considerable developments can be expected in the medium and long term (over the next decade) and should be taken into account by railway companies making strategic choices:

· constant and rapid improvements in computers, terminals, memory capacity and the man-machine interface,

- progress in battery technology - more powerful and lighter products,

- development of mobile telephone capacities (data interchange, messaging, multimedia functions),

- extension of the Internet,

- increased accuracy in satellite-supported tracking and tracing up to five meters).

Conclusions

Implementation of A VI has been a success in the United States because all the major railway operators on the market agreed to introduce the technology across the board. For the time being, the train operators and infrastructure managers of Europe do not seem disposed to adopt the same joint approach. That does not preclude a single company or a small group of companies wishing to go down this path from installing the necessary equipment for use in a limited geographic area.

The latest technological developments have been favourable to satellite systems: falling costs, rising accuracy, and autonomy from infrastructure. These systems are probably set to develop most in the coming years.

To date, those operators interested in making headway on this front have by and large chosen to develop applications limited to sub-fleets of wagons or locomotives to overcome very local problems. It would be worthwhile consolidating these limited steps into wider programmes, including at an international level.

The benefits and shortcomings of each technology appear sufficiently clear for a choice to be made between simply using existing (or enhanced) information systems, AVI and satellite, on the basis of a detailed study of prospective railway requirements.

Although the comparative advantage of satellite technologies is growing rapidly, it is clear that the other two families of solutions will hold their own and continue to develop in the coming years.
