Hierarchized digital control of logistics systems: handling and tracing applied to the railway transport case

Renato Rizzo

Department of Electrical Engineering – University of Naples Federico II, Naples, Italy
renrizzo@unina.it

Abstract – **In intermodal systems there are some logistic problems due to the handling and monitoring of loads. In such a framework the railway transport could represent a good alternative to road transport if some improvements are introduced to make it more attractive and competitive for end users.**
Some critical aspects in transport logistics organization are analysed in the paper. These aspects are, in particular, the system for individuation and location (monitoring) of the loads, the current logistic procedures and referred regulations.
A Hierarchized Digital Control of logistics systems for handling drives and tracing of goods is proposed.

1. Introduction

In goods transport are integrated different transport systems (road, railway, etc.), they constitute intermodal systems introducing some logistic problems due to handling and monitoring of loads. In this frame the railway transport represents a good alternative to road transport only if some improvements are introduced to make it more attractive and competitive for end users.

To reach this result it is necessary that some limitations are overcome, especially in transport logistics organization some critical aspects must be considered and corrected. These aspects are, in particular, the actual system for individuation and location (monitoring) of the loads, the current logistic procedures and referred rules.

The integration and optimization of intermodal sections for goods transport with particular attention to a section of railway line can be obtained by means of monitoring procedures for the improvement of the transport, identification of goods and criteria of continuous quality improvement. It is necessary to study the possibility to optimise the logistics through the definition of:

1. Loads monitoring is actually realized using communication and data transmission by ground net or radio transmission, it must be improved introducing a continuous tracking (tracing of goods) using satellite communication systems;

2. Transport logistic organization with all procedures, standards and rules that must be harmonized at European level taking into account their influence on technological tools;

3. Drives for loads handling must be coordinated and managed using a hierarchized digital control of the drives.

The goal is the optimisation of the intermodal logistic. The prediction of time arrival of goods and following transport destination allows, in fact, the application of optimal procedure for the logistic management, addressing the traffic on corridors that are less congested, reducing the number of tracks and trains that run with no load and levelling the use of drives for handling operations.

Present needs in goods transport require that loading and unloading operations must be realized in "intelligent way", this means that the arrival and departure cadence of trains must be organized taking also into account the safety/security aspect, with step by step information about execution and correctness of all the operations.

The control of logistics is based on the use of a monitoring system for goods transport. Thanks to the identification of loads position during the transport it is possible, in fact, to predict the arrival time and to program and organize logistics operations in order to reduce execution times and optimise the procedures with the aim of respecting the logic "Just in time". For this reason it is important to consider the input coming from satellite data transmission systems and informatics supports managed by supervisors of the co-ordinated transport system. High tech. products are nowadays widely diffused, telecommunication and informatics tools are powerful and precise and also economically competitive. Data transmission is realized using mainly radio communications with GSM and satellite communication systems.

2. Handling and tracing of goods in logistic systems

Actually goods transport have monitoring systems that is a tracking system which locate the exact position of the train when it arrives in correspondence of some monitored position along the railway track. The situation is not continuously under control. A modern monitoring system must operate assuring a tracing function, this means a continuous tracking in each section of the railway line. This system requires an automatic identification and location of the load, and continuous up to date information, based on radio communications and satellite. It is any case necessary to have a supervision and operation centre.

Thanks to the development of information technology for application in transport it is possible to optimise different transport systems and realize the so-called inframodal optimisation.

Regarding the handling, the drives must be characterized considering the particular application, it is required a quick and precise position control with high dynamic performances. Good performances can be obtained by a digital control of electrical drives, they can be easily used in transport logistics because of the possibility to set up a hierarchized control able to realize the coordination of operations. It is important to take care of the interfacing system to connect drives to the logistic system. The data transmission system must be chosen considering safety and security problems and data transmission times.

The monitoring and hierarchized digital control system for handling drives and logistic system must be designed producing a simple product with a user friendly management, it will be then possible to control errors, improving the diagnostic. A simple and modular control system reduces costs and makes it possible to upgrade or modify the system, giving the opportunity to use it in a situation with transport management not assumed by only one company but by different concurrent.

The architecture will be characterized by an interface system easily adaptable to different users systems, based on the application of standard transmission protocols (i. e. http/java).

A general structure of a monitoring (localization and individuation) system for loads is made of:

- Set of sensors;
- Mobile control unit on board;
- Network for data transmission;
- Server for control and supervision of the system.

The hierarchized digital control system for logistics handling and tracing that can be adopted has to respect the above considered general structure, using a satellite based transmission system.

From the national and international context of goods transport it can be deducted that the infrequent use of railways for goods transport is due to:

- the present commercial speed of railway transportation;
- the unreliability of delivery time;
- the lack of information on the localization of goods.

An increase in the rail road traffic can be achieved:

- by increasing the commercial speed;
- by giving a firm delivery time and by continuous tracing of the goods along their track.

The state of the art has evidenced that the commercial speed is limited because of the following causes:

- the necessity to respect several procedures imposed by the countries crossed by the axis;
- the difference of electrical power used in the railways of various countries;
- the difference of the rail road layout and the related tolerances;
- the necessity of repeating control procedures according to varying national procedures;
- the lack of a coordinate system to locate the goods;
- the European standards that liberalize the use of rail roads.

The uncertainty of the delivery time depends on:

- managing reasons;
- the lack of continuous monitoring;
- the organization of goods dispatching centres;
- the difficulty to exactly know the exact travel time.

To make railroad transportation competitive with road transportation, it is necessary to improve significantly and substantially dispatching logistics, including the automatic retrieval of goods, and to modify the technological modalities of movement within the intermodal nodes as well as to harmonize procedures and standards when railroad axes cross different countries.

The improvement of dispatching logistic can be obtained by:

- the integration of information systems along all the railroad axes, including the intermodal node;
- the development of satellite control systems;
- the study and proposal of solutions aimed at minimizing the loss of information (branches in tunnels or where a phone connection is unavailable);
- the development of procedures to asses the quality of the whole system which manages the dispatching logistic.

The above mentioned satellite and information systems must be developed in such a way as to allow the forwarding agent and the customer to know in real time and by means of a continuous flow of information the state and the position of the dispatched load. They will

allow an easy and continuous access to such information warranting, at the same time, the privacy of the information and the possibility to activate various procedures with the purpose of intervening on the railway transport manager in case of postal errors of the load. This information and the active intervention of all the concerned subjects is in fact of an extreme importance for the aim of correspondence of the sorting logistic to the procedures of quality systems that cannot be limited to those relative to the state of the load, but must also involve those acting to make corrective actions if an interruption of the goods flow occurs. In the development of these systems an open architecture will be provided in order to interface with analogous systems developed on other paths or in combination with other transport nodes; this means warranting expanding possibilities (modular system). The quantity and the quality of the available information will be in proportion to the effective requirements of the transport and won't be uselessly redundant. All the information will regard essentially the position of the load, the distance covered, the space and the time still to be covered to finish the whole route and the state of the load (if stopped or running). The movement of the inter modal nodes will be organized in order to satisfy the present requirements:

a) Planning the nodes in such a way that none of them will have less capability than any of the afferent lines;
b) Providing each node with an automatic recognition system for the instantaneous diagnosis of its employment state;
c) Ascribing to a central elaboration of the node and to its artificial intelligence the decisions on the action to be activated each time;
d) Providing the use of motion systems with hierarchical numeric control and/or linear electrical drives controlled with innovative techniques based essentially on neural network and fuzzy logic.

3. Hierarchized control program

One of the aims of the researchers is to determine the effective capacity of a specific connection corridor by defining and identifying structures and management programs.

In order to verify whether the goals of the researchers can be effectively achieved, a hierarchical calculation program should be set up; this, using the information of satellite monitoring and following the programmed plan for the vector co-ordination, will arrange load and unload operations, managing in a subordinate way the motion instruments. It can be considered the block scheme of figure 1.

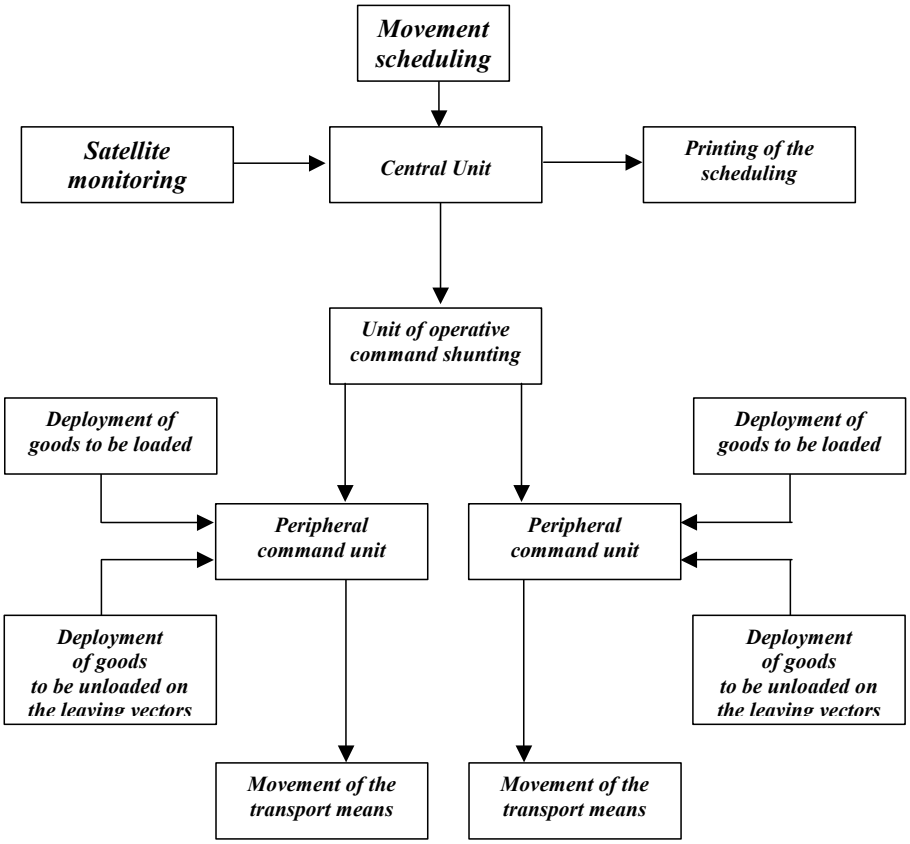

Fig. 1. Block diagram of the hierarchical system for good handling

The central unit will be programmed in order to define the operations of the peripheral units in the different load and unload placements. If the volumes and the weights of the starting loads are assumed as known, the central unit will predispose the optimized loading plan, defining the position of the single objects for the realization of the whole starting goods set. The information will be transmitted to the peripheral command units, which must serve to command the electrical drives for the motion. The central units will transmit the destinations for the incoming loads. The peripheral command unit will dispose the catch or distribution plan of the goods following the information arrived from the central unit and based on the local knowledge of the goods placing to be loaded on the starting vectors.

4. Conclusions

Intermodal transport systems have been considered in the paper, their optimisation by means of the solution of some logistic problems due to the handling and monitoring of loads is outlined.

Critical aspects in transport logistics organization have been analysed in the paper. These aspects are, in particular, the tracing and handling of the loads. A hierarchical calculation program has been set up and presented in the paper, in order to respect the logic “just in time”. Using the information of satellite monitoring and following the programmed plan for the vector co-ordination, the proposed program will arrange load and unload operations, managing in a subordinate way the motion instruments.

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