Multi-fleet management system for public transportation companies by road in the Barcelona metropolitan area. Multimode information manager assistant for interchange transportation modes

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Abstract

The Fleet Management System (FMS) is a system to manage the network, which, with the help of Global Position System (GPS) satellites, is able to locate the 27 operators of the buses and inter-urban bus lines in the Barcelona Metropolitan Area (BMA).

The most notable characteristics of this system include the following: it provides the operating companies more efficient management tools than those they have, it allows for real-time information regarding bus location, and it integrates this information with other bus FMSs and railway traffic control centers already established. This would help the Metropolitan Transport Authority (MTA) efficiently coordinate the management of the interchanges where different bus and railway lines cross. It would also help transport users of these lines keep informed about incidents that affect the service. This will be accomplished through the installation of displays both inside buses as well as at bus stops, stations and transfer points. This information will also be posted on the MTA website.
1 Introduction

Since 1997, the Metropolitan Transport Authority (MTA) has been the consortium that has governed public transportation in the Barcelona Metropolitan Area (BMA).

The shareholders include the autonomous government of the Generalitat de Catalunya (51%), Barcelona City Hall (25%) and the Metropolitan Transport Entity (24%). These entities finance public transportation. The Spanish government is equally represented in the Administrative Council and is involved with the issues.

The governmental sector is an important stretch that covers Barcelona and the seven regions that surround it. This territory covers 3,200Km² and there are 4.2 M inhabitants.

The Fleet Management System (FMS) complements the ticketing system that was integrated in early 2001. It operates as a common ticket system for the group of operators and represents an enormous incentive for public transport users given the fact that it legalizes the transfers between different operators within the limits of a destination-origin trip. The main complement of the FMS with regards to the ticketing integration implies that travel between two zones will be automatically steered by the FMS.

There are 41 public and private transport operators. This number includes the National regional railway (RENFE), the Generalitat de Catalunya railways (FGC), the Barcelona subway (METRO) as well as the Barcelona bus operators and the inter-urban buses that operate between the different populations within the 200 municipalities of the BMA. Some of these operators already have a FMS system. In the case of the railways, this system is called traffic control center (CTC) and for the buses there are individualized FMS.

The MTA thought that it would be strategic for a FMS system to be equally implemented for all operators, no matter what the size. From a ticketing standpoint there exists a common system for all operators as well as for float operators. It would additionally support public transportation of the BMA of each individual. The management of crossed information and common infrastructure is attributed to the MTA.

2 Objectives

The objectives combine the details of the operating businesses benefited by the system and those of MTA destined to the public transport user’s perception. This is a sole vision of the public transport system for the Barcelona Metropolitan Region and will have a bearing in lowering private transport. The legality of transfers attained through the ticketing system and information
combined from the different operators will continue in this same line of vocation and user work awareness.

Specifically the project intends to:
- Provide the operators with a work tool adapted to the specific need and is different according to the size of the fleet. These needs range from voice communication between vehicles and the controllers of each fleet to sophisticated informational applications that help in the decision making process and the On-Line regulation of the entire fleet.
- Obtain information in real time about the location of the buses as well as their position and the waiting time for the next bus.
- Combine this information with that of other existing management systems of fleet of the other public operators.
- Keep transport users informed about the waiting time of the vehicles and the transfers or interchanges as well as keeping them informed inside the bus.

All of this is designed to strengthen the perception of the transport user that his movement is regulated through a metropolitan system that works on an integrated scale and whose goal is to make his trip easier.

Likewise, the information that the system supplies allows for a simplification of work involving operator hours and services of the MTA. This is competition entrusted for the BMA. For this reason, the MTA receives information of the actual functions of the operators and that makes it easier for the planning work and the surveillance of the services.

3 Magnitude of the project

Currently, 27 operators and 502 buses that are spread out in the BMA have the system. There are 80 informational alphanumerical displays that depend directly on the system and are divided by geography in the main points of modal interchanges.

The system can hold up to 800 buses and if necessary, will allow for its capacity to increase up to 60%. Minimal increases of hardware and software to the infrastructure base can be applied.

The cost of the system can be broken down and the most important are: the radio network (0.9 M€), the equipment installed in the buses and information panels (3.88 M€), the crew of management in the MTA and in centers of operation management, information like the searchable cartography of Teleatlas and the base cartography in the Cartography Institute of Catalunya, works at the bus stops, nomenclature, equalizing in bus stops (4,500 digital and 9,800 physical) and the introduction of data with regards to stops, services, etc. (0.37 M€).
4 Multi-fleet management systems evolution

Recently, the evolution of the fleet system management for passenger transportation has been suffering in terms of an important advance. The aforementioned process can be summarized in terms of three big system generations.

4.1 First generation concepts

The first FMSs were introduced in the 70s and 80s. They covered the fundamental aspect of voice communication between driver and the dispatch desk. There was a basic function of fleet management due to a tracking system based on a series of markers located on the bus route.

4.2 Second generation concepts

The second generation of FMSs came about in the 90s due to the generalized use of tracking through the GPS system and the evolution of information systems and data base management. The improvement in the precision of positions and the potential for calculations in the servers allowed for a more precise and integral management of all resources involved in the FMS. It is during this time frame when information panels were introduced at the bus stops because information was available about time as well as obtaining more precise information about arrival times at the bus stops along the route.

4.3 Third generation concepts

The objectives that the MTA plants in the moment of detailing the FMS has given rise to a more advanced concept that is called Third Generation FMS. The main differences between this system and the aforementioned systems include the following: giving service to the various operators with just one system (in this case, it is to 27 operators), fleet management with profiles of urban and inter-urban operators and the fact that the MTA plants to administer multimode information for all the BMA passengers. This last aspect makes it necessary to implement a system of interchanges of information with the rest of the integrating operators that already have management fleet system and to administer this information currently and in the future.

Besides information panels at the stops, there are new concepts of multimode information regarding the MTA. It is the only group, due to its idiosyncrasy of authority of transport, that can arbitrate and distribute information to the information points of the MTA, other operators and advanced applications of information to the transport user that will allow him to plan his trip beforehand just like the internet. The internet is an already known system but in this case it implies the entire integrated operators.
4.4 Third generation costs

Naturally, other arguments exist within the framework of the third generation that encompasses aspects beyond multimode information. One of these is cost. It is clear that for inter-urban transport, communication infrastructure is a cost that encumbrances (because of required coverage) the total costs of intelligence systems. In general, these costs are not justified if there is not a minimum fleet size of around 300 vehicles. Keeping in mind that operators of the buses of FMS and property of BMA have fleets under 120 and many under 50, it is necessary to share these types of services.

5 Multi-fleet management systems concept

This concept implies that one system provides service to various operators with distinct problems, sizes and geographical distribution. This situation gives rise to the following main characteristics:

5.1 Resource sharing and scale economies

They are common for all operators:

The infrastructure of communication: network transport, switching elements and connection with the Computation Center.
The control center: data base management system, server software, recordings of voice communications.
User information systems: street information panels and information sources (internet/wap).
The information regarding intermode connections that would be very complicated outside the multi-fleet FMS setting.

All of this allows those businesses involved with the MTA to access technology and resources that would otherwise be individually hard to tackle.

5.2 FMS and the business

The large variety of current businesses has caused applications to be designed. Thus, each operator decides to what degree he wants to have the FMS functions. The other functions can be viewed through the central administrator or through an automatic way using certain conditions.

5.3 Multi-business management

The control centers of all the businesses are linked through a virtual private network (VPN) allowing for security control and centralized authenticity in the central offices of the administrator.
There is stagnation between the different businesses and there is no link with other fleets besides their own.

The concept of friend fleet (pertaining to other operators) and friend operators is used. Under this system, a business can delegate, at any moment, the control of all or part (of a group of lines) of its fleet to a friend operator. Likewise, an operator can make use of these friend fleets to cover part of his service. This is common in businesses where there is one management that requires this type of specific functionality.

5.4 Integral management of transport in a geographical area

The FMS, together with the integration ticketing system, measures the concept of global management of the mobility as a tool for the improvement in the quality of service to the public transport user.

The information obtained from the FMS allows all the trips to be consulted within the geographical setting of the BMA. This accounts for 250,000 movements per day. All of this information allows for an analysis to be performed regarding the demand of mobility of the BMA and the planning of services. This is encompassed by the MTA.

Likewise, the availability of all the data, up until now dispersed, allows for information to be distributed to all transfers in real time as well as information about alarms and fires. This favors global decision making in all aspects.

6 FMS makeup

The makeup of the different systems that constitute the FMS of the BMA will be addressed.

6.1 Global architecture

Each one of the vehicles pertaining to the MTA has been equipped with a set of on-board equipment. Data can be obtained in the computer control of each vehicle. For example the position, velocity, route, location or the time arrived at the last stop, can be tracked and transmitted through a radio communication system to a central server located in the MTA installation site. Each one of the eight repeaters of the radio network has a capacity of 300 vehicles for each radio channel of 30 seconds.

Each server located in the MTA, has a main function to group the data and the voice communications by businesses and resend them through a series of processes through public Digital Integrated Services Network (DSIN) lines.
The true advantage of the FMS system lies in the fact that it not only makes use of the positioning data, but rather confronts them to another series of data like line and route configurations, schedules, services, the conductor that is in each vehicle, etc. that allows them to perform regulation functions and that permit them to constantly calculate prescheduled times for the arrival of the vehicle at the next stop. This process is done in the server that redes the use of the communication system to transmit information to the posts of user information.

As it can be seen, one of the newer aspects of this system is the connection with systems of information of other transport operators in the metropolitan setting like the FMS of Barcelona and Badalona bus operators, and CTC of the train information systems of the METRO, FGC, the trolley and RENFE.

6.2 Makeup of the system in the buses

The set of equipment related with the communication of data is managed through the computer.

The GPS receptor is connected to the computer and receives signals from the GPS satellites and calculates the positions with an exactness of 10 meters. In the case in which a signal of the satellite is lost due to the presence of tunnels or high buildings, a navigable system is used where the signal of the odometer of the bus is utilized.
The connection to the ticketing system of the vehicles and the installation of infrared counters in the doors allows one to know the occupancy of the vehicle with a 95% exactness.

In each bus, a system of information for the passenger has been installed. There is a display and a reproduction of a voice connected to a megaphone. This system allows for the passenger to hear the next stop and the transfer points as well as a repetition of a prerecorded message.

To interact with the system, the driver has a console with messages that allows him to send and receive alphanumeric messages as well as to solicit communication with the dispatch desk.

The equipment's ability to know its own position and the existing connection with the ticketing system whatever the model may be, allows for the change of price zones as well as the automatic change of stops.

Voice communication between vehicles and operation systems can be grouped in 3 different ways: ordinary communication of the driver through a microphone and loudspeaker, emergency communication through a hidden pedal and megaphone communication. Thus, the operator can transmit a message to the passengers in the vehicle.
6.3 Operator jobs

Depending on the size of the operator's fleet, different types of management centers are used although the equipment is the same.

6.3.1 Management of voice communication

It is the most basic management mode that is cataloged as a sole communication voice. It is foreseen for the small operators that do not have a permanent supervisor and from their point of view manages the voice communication. Positioning data and alarms, for example, are stored in the database just in case they are needed to be consulted.

6.3.2 Management of vehicle position and voice communication

Allows for monitoring vehicles and voice communication and is focused on operators that have a supervisor but do not require fleet regulation due to the type of business they perform. Thus, voice is managed and texts are transmitted to the driver's console and interior displays in the bus. His equipment has a workstation connected to the MTA management center.

6.3.3 Management of basic regulation, location and voice communication

In this case, the daily expeditions are configured but the concept of daily assigning does not exist. The aforementioned assignments are established by the introduction of data expedition through the ticketing system on board the bus. In the moment in which an expedition is carried out through, it is sent to the FMS and operates on the basis of information. The relative functions about the regulation of the line are available. The driver receives the information through his console.

6.3.4 Complete fleet management

It covers all the functions of the FMS. It allows the assignment of the daily services that are contrasted with the data that are introduced into the the ticketing system to initiate each business. It is the widest regulation. It also has analysis tools and can manage information panels on the stops.

6.4 Multimode information systems

This concept, part of the FMS third generation, implies that the system receives information from its own buses, from the control centers of each one of the companies of the FMS and other operators for distribution in terms of diffusion of the MTA or other integrated operators. It is based on two basic principles:

6.4.1 Infomodality

The infomodality is the centralization of information of fleet managed directly by the FMS and the rest of the operators.
To obtain information regarding Infomodality of the other operators, a communication protocol has been designed with the operators that already have a fleet management for buses and traffic control for railways. The protocol allows for the centralization and distribution of the relative schedules and passing times and allows notice in interchanges to passengers.

6.4.2 Infomobility
Infomobility is a consequence of everything mentioned above. Having this information allows the MTA to distribute the information through the following methods:

In the inside of buses, the system gives anticipated information of travel connection points to the passenger so that he can decide if it were the case regarding interchange modals.

In information displays located in the main transfer points of the BMA, information about the arrival of operators is given.

Information is supplied to other systems utilized by the operators that have information systems for the client to complete their information in the exchange points with other operators.

Finally, information is contributed to the user through an information web system that allows lines, schedules, transfers, routes for a trip that requires diverse modes of transport, as well as on-line status of each business to be checked.