Architecture of an integral information system for public road transport of passengers

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Abstract

In this paper we present a mobile information system for a public utility company of road transport. The main achievements are the improvement of the following strategic aspects: service for the users, planning and decision making of the enterprise. The most relevant system characteristics are: the use of new information technology and the use of standard technology. Now the system is working on the Gran Canaria island, Spain, by the road passengers transport company Global Salcai-Utinsa, which has integrated the information produced on board in real time by this system.

1 Introduction

Generally the information systems of the companies of passengers road transport have a common and important problem: the difficulty to integrate in a properly way the mobile information systems installed on the buses, so the companies can not access at the precise time and properly way (amount and format of the data) to the information produced by onboard mobile systems. This difficulty is important because these systems produce the information about the production of the enterprise and from this information the evaluation of the planning fulfilment (expeditions, times table, number of passengers, etc.) is calculated. Probably, the reason of this problem is that conservative technical criteria prevail in the transport enterprise when they make the decision about the kind of system to install on board, the final result is that generally these systems are based on obsolete elements (hardware and software). In our opinion, now the information technologies can solve this problem with reliable, scalable and
economic solutions that will produce a more attractive public transport for the user, an important aspect to improve the way of life of the citizen [1]. These profits are converted in strategic goals in places like the Gran Canaria island where:

- The road infrastructure is conditioned by a complicated geography and presents serious deficiencies which difficult the development of the transport of public utility.
- The only means of transport are the public transport by road and the private vehicles (there is no train or underground available).
- There has been an enormous increase of private vehicles, producing motorization levels similar to those of metropolitan areas with higher income levels which cause important traffic jams.

2 Goals and general strategy

A method to face the problems of traffic jams, which produce an inefficient public transport is by improving the management methods and the control of the transport lines. This improvement can be achieved using new systems and technologies nowadays used in railway and underground. Obviously there are other methods of improving, but they are based on the priority of the public transport in traffic circulation or on other actions of infrastructure that facilitate the service, but these actions depend on external organisations, normally national or local governments.

Traditionally, the control of time tables and planned services of urban and metropolitan buses lines has been made by lines chiefs situated in control points placed on the lines heads or in intermediate relevant points of the way. This system presents the following disadvantages:

1. The buses only can be controlled in these specific points, so we do not have information about the position or other relevant incidents of the road. This produces an accumulation of delays and too long response time.
2. There is not a global point of view, so the regulation decisions are made for single buses, and when they affect a group of vehicles, these decisions can not be fast communicated.
3. The number of people doing control tasks is necessary high.

These disadvantages have been partially compensated by using mobile communication systems, but most of the main problems remain. New control systems, called operation aid systems, have been developed, gradually incorporating new functions based on technology innovations available at each moment [2], doing possible an efficient use of the resources of the transport enterprise. The current systems present the following problems [3]:

1. They are based on specific physical elements that can not integrate the ticketing system and other electronic devices of the vehicle.
2. They have been basically developed for urban transport in big cities, more orientated to frequency control than to time tables fulfilment.
3. They do not provide the vehicle an intelligence level that permits its self-control. That means that all the incidents have to be solved at the same control point, doing difficult the decisions making.

From the point of view of a transport company the goals to achieve are the following:

1. Improvement of the service quality: the fulfilment of the time tables, basic item of the management strategy, facilities the general policy of maintenance and increase of public transport, making it more attractive. It also achieves an economy of fuel, because the quality of the service will be based on fulfilment of times tables and not on high frequencies.
2. Improve work conditions, because of a better communication between the persons in charge of fleet controlling and drivers, more security and a fair distribution of work.
3. Improve the internal operation of the transport enterprise, because a suitable information is available, facilitating the planning and the decision making in a relational and homogeneous way.

In order to achieve these strategic goals, the following technological requirements have to be fulfilled:

1. Support the required amount of information.
2. Process the different kinds of information required.
3. Access to the information at the appropriate time.

Achieving these requirements, the company will be able to control the operation of the fleet from a single point in real time. A second set of goals are related with system design requirements which affect strategically the enterprise:

1. Standardisation of onboard elements: we have achieved a system based on use of standard physical and logical elements. So, the enterprise has more freedom in negotiation with suppliers, decreasing costs and adding independence in the future evolution of the system.
2. Flexible logical structure in order to adapt the system to different contexts of work achieved by use of flexible and scaleable standard physical elements according to modern methodologies.
3. Integration of all the onboard devices, concentrating all the driver's operation in the onboard console, avoiding the proliferation of devices that could distract the driver's attention.

3 Description of the system

Now the system is working on the Gran Canaria island, Spain, by the road passengers transport company Global Salcai-Utinsa. It permits us to know the state of the fleet, to make decisions at real time, moreover it facilitates the planning because it provides a more proper information. For public transport these facilities are very important strategic aspects, yet more important if abrupt changes in the user demand are produced, for example the company Global Salcai-Utinsa must
operate in tourist areas where the weather changes influence directly the users demand. In this context, each bus of the fleet must be ready to do any service and to work in any zone covered by the enterprise. Considering this requirement and the communication infrastructure available functionality [4], [5], we developed a system based on the exception where the onboard mobile systems have the necessary resources (devices, processes and data) to operate in any work conditions and only when a relevant event arises, communication with control centre is established. In the next figure we show an overall view of our information system, in which the main resources are represented.

![System overall view](image)

Figure 1: System overall view

From the point of view of the system functionality, it is configured by the following subsystems:

- Ticketing subsystem. It is responsible of the different tariffs and payment ways (cash, magnetic cards, etc.) used by passengers. This element is supported both on mobile systems (now it is executed onboard of 200 buses) and no mobile systems (for maintaining the data base of tariffs and payment forms).
- Planning control subsystem. It is responsible of the planning fulfilment verification, acting if it is not fulfilled. The console system and mobile systems execute this element. This element is executed in the on board systems and the control console of the fleet.

- Production data processing subsystem. It is responsible of processing the data produced by the onboard mobile systems (income, time tables of the buses, number of passenger, etc.), this processing is made at real time and the results are available in the departments of the enterprise at real time too. This element is executed in different computers of the company net.

- Fleet administration subsystem. It is responsible of the proper work of the elements (devices and processes) that configure the system, with special attention to mobile systems; this subsystem has a special tool for planing and controlling the update of data and process versions in an automatic way. This element is supported on the fleet automatic administration system and the mobile systems. This element is executed in an specific computer of the company net.

- Communication subsystem. It is responsible of connecting all the elements of the system using the available communication basic infrastructure (radio trunking system and company local net). An important achievement of this element is that the mobile systems are integrated in the company information system as any other element. For example, a user with the proper permission can access from the company offices to any onboard system, this is a very important property in order to facilitate the administration and maintenance of mobile systems fleet. In short time we improve our system using data transmission services by mobile telephony (for example GSM).

The elements explained before configure the basic logical architecture that has two main properties: it is driven by exception and it is a distributed system in a sense that important functionality can be supported by different systems of the company net. This basic architecture permits that other traditional logical component of the company can be improved by the use of the proper information produced by it. For example:

- User information subsystem. This element has been improved because any exception that affects the passenger service, for example delays, can be communicated at real time to the user.

- Planning subsystem. This subsystem has been improved because the information is available now in a better way: access time, amount and format. With this facility the service to the user and the economy of the enterprise can be optimised.

From a computing point of view, the main characteristics and requirements of each physical element that configures the information system are the following:

- General purpose processing systems. In these systems the planning, management, takings process and statistics processes are executed. It does not require a specific hardware/software platform.

- Data transference systems. By this elements the onboard mobile systems are integrated in the corporate net. These computers are equipped with interfaces
that permit the connection among the system by different media (physical cable and radio frequency).

- Control console of the fleet. This element is not mobile and it permit us to know if the buses follow the planing. Moreover, using the information produced by this element, the operator must solve the exception to the planing produced during the work of buses. Two aspects are critics in this element: first, the man-machine interface; because the way of presenting the information must facilitate the decision make, and second, the tools to aid the decision make; because the decision must be made following uniform criteria, resources such us expert systems could be very appropriate.

- Onboard System. It is installed on the bus (now 200 buses). The main element is a rugged computer (it works in adverse conditions of temperature, vibrations and power) which controls the other onboard devices: driver console, magnetic card reader, GPS receiver, radio station, wireless local net device and power-temperature management device. This system supports the following facilities: ticketing, planning fulfilment control, onboard relevant events register, autonomous positioning, user and driver informing and environment parameters control. The information produced during the services is processed, storage and transmitted to elements of the company nets. In our model, the onboard systems transmit information such us: overall information about services (bus, driver, date and time of the start, date and time of the end, takings, amount of passengers and duration) to the collector’s office, detailed information about services (distance covered, date and time of the start and end of the expedition, passing times, for each passenger journey the time of the start, the point of start, time in destination, point of destination, payment form) to the production data processing subsystem and technical information (device and process alarms) to the fleet administration subsystem.

4 Conclusions

Nowadays, the explained system operates on Gran Canaria Island, with a fleet of 200 buses, 1600 daily expeditions and an average of 17,000,000 passengers a year, with it the company Global Salcai-Utinsa has an integral information system. It means, in all aspects of the transport enterprise (management, planning, operating, maintenance, etc.) achieving the disposal of the necessary information in each moment and at the precise time. Moreover, the system provides a proper information, so it is available at the proper time and in the proper amount and format. To resume, the main characteristics of our system are:

- It works in a metropolitan environment. Traditionally, these systems work in urban contexts and this is an important aspect that concerns the quantity and frequency of the information to be transferred between the mobile system and the central system.

- It is capable to work in a complicated geographic environment. Moreover it has a metropolitan field larger than an urban system. In our case we have important geographic difficulties (abrupt valleys, mountains) that do not facilitate the communications.
- It is based on standard technology. It is an important strategic improvement because in the transport technology context there are specific solutions that difficult the technological innovation in the enterprise.

- From an operational point of view, the system is based on the exception control, only when a relevant event takes place, the communication between a onboard mobile system and the control centre is established. This is another important difference between our system and other current working for urban transport such as the systems of the city of Alcalá de Heneares, (Spain) and Vizcaya (Spain). Actually relevant event monitored by the system are events that affect the normal fulfilment of the planning and time table: (work starting of buses and drivers, risk of delays in the expeditions, early arriving to the bus stop, passenger full bus during expeditions) and events associated to alarms produced by devices and process of the onboard systems and alarms communicated by drivers.

- From an operational point of view, the intelligence of the system is distributed. This is another important difference between our system and the other present system. In these ones, all the planning information is placed in the control centre. In our model all the onboard mobile systems have all the logical elements to operate in any operation context without a permanent communication with the control centre.

To end this paper, we must say that in our opinion this kinds of system will develop according to the growing of the new technology of the information, specially the mobile communication. Moreover using this kinds of systems, the public transport companies by road will can improve the service to the user and they will can increase the offer supplying a better information.

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