

Extended Abstract

Passenger Transportation Services in Real Time Management

Ricardo Gomes Rodrigues

Av. Praceta Estado da Baia nº 12
1º B S.Marcos
961694666

gomes.rodrigues@tagus.ist.utl.pt

ABSTRACT

This article presents an approach for create solutions that tries to meet the real-time management needs, from all the information obtained by the public transportation service management systems, which is gathered globally and by each operator area. By real-time one means the time required so that one can make on time decisions about certain information. On the systems and applications universe that manage real-time information, only few do not present the lack of integration with all the other systems, which causes confusion and excess of information that difficult efficient management, and creates barriers on information crossing for posterior analysis, even so, this more sophisticated than usual scenario, occurs only on the major operators. On the other hand, the smaller operators, the none informatization scenario is still very frequent. On this context, it is proposed a platform capable of providing integrated functioning between all those systems, either those that manage or not in real-time, but that in many cases share common information.

Keywords

Integration, regularity, dispatch, operations, real time, transports

1. INTRODUCTION

Nowadays there is a growing need on the public transportation industry, to provide to their customers (passengers, operators and crew) a vast set of better quality, services and information available on useful time, to answer to the growing demands and needs of the transportation industry and society on general.

In these conditions, it's crucial to understand and "attack" the problem described below.

1.1 Problem

Nowadays and since always, passenger transportation service execution control in many cases does not use technology, instead it is based on human resources (inspectors), spread throughout strategic points of the service area. This situation still occurs very frequently, specially on the smaller operators, interurban operators, or long course operators. For example, if we simply observe the buses leaving Marquês do Pombal, there is the presence of inspectors registering the exits. On the other hand, major operators were the first to adopt computerization of these services. Operators like CARRIS, STCP or HF, started introduction of these systems, normally named SAE, for regulation control, positioning associated with information provided to passengers, that brought to a command central, the

street inspectors, where they made regularity management, using equipment provided on the vehicles to communicate.

Transportation services supported by a technological platform, that manage real-time information, had during many years a big variable for they success (or failure), precisely the technological component, namely quality and capacity of communications, and response mechanisms associated to fault recovery, as well as the time prediction algorithms quality, displayed to passengers.

Nevertheless, with the constant technological evolution, the tendency is for the quality of these services improves, and the mechanisms need recovery from fault situations and algorithm, on communications seizes to be a main issue.

These systems, nevertheless, appear on a not integrated way with the remaining company processes, namely those more related are: incident management, expedition, maintenance (through traffic occurrences, and vehicle needs), fare collection (application of different fare models, depending on the location). These areas, on one hand it is normal, not to be computerized and with many paper based processes, voice and excel. On the other hand, when computerized, they are rarely in coordination with the central command systems.

Nowadays, additional execution control systems begin to appear, some with more real-time control then others, like video surveillance systems (buses, and buses corridors) or passengers counting systems. The not integrated functioning of all these systems, causes confusion and excess of information, that hardly contributes to real-time management, and brings difficulties to information crossing, for later analysis.

Besides these systems, there are a series of interactions with external entities, like on board installed equipment suppliers, security authorities, etc.

Being that presently, there is no standard architecture in the way this type of solutions are built with external interactions, there are two approaches that tend to be followed:

a. Introduction of regulation systems, isolating fare collecting and using integration and sharing information techniques.

b. Using fare collecting techniques, introducing service control component (eg.: GPS validators)

More so, what happens in real-time has impact on other areas, namely, planning and maintenance, because malfunctioning, accidents or other situations that occur in real-time, imply

changes in these plans. It is important to know about accidents, as soon as possible, so they can be addressed.

A service with these characteristics can cross different types of information, being those:

- Real, that consists on information about what really is happening, regarding the current service being executed;
- Planned, that consists on information is programed based on other information (closed roads, John Constantine is sick and took a leave for May 2nd);
- Theoretical, information defined initially and few times revised, as information related to transport schedules.

All this vast and detailed knowledge about what was planned and defined, related to the knowledge about what really happens on the field, acquired in a instant and electronic way, also reflects on a better information quality provided to passengers.

Besides all this confusing scenario, influenced by current mobility standards, that grow each day with a bigger part of irregular standards, operators are starting to offer a vast set of differentiated services, that obviously also have different technological solutions. For example, some of those services are bus-on-demand (on its different forms), or car-sharing.

The big problem nowadays is in how to manage all this information in real-time, that is produced by these systems, either centrally, either on each operators area, that also need real-time information, like intervention depots, stations (expedition) and maintenance, with the perspective to provide guarantee of an integrated functioning between all those elements, guaranteeing quality information. Being that the big service variable of this kind, is in the way the central solution organizes the information gathered from the systems, how it represents it on a synoptic shape, and how the central solution can support decision making.

This problem is well-known and has been approached in several ways. Namely through the definition of standards at the data model level. Nevertheless despite several efforts, this problem was never solved, discussions and researches were made [1]

But the fact is that big efforts to schematize a solution with those characteristics were also not found, with the possible exception of some references of USDOT (United States Department of Transportation), but that in general always promote not integrated functioning, that does not meet the real-time management needs.

2. BLIC GMBH System

BLIC GMBH [2] with offices in Germany and Dubai is a leading consultancy for planning, engineering, tendering and introducing IT systems for public transport systems.

They present a state-of-art Automatic Vehicle Management with Operation Control Center, integrated with a RTPI (Real Time Passenger Information) and a AFC (Automatic Fare Collection System).

Functionality of AVM and Passenger Information Systems:

The AVM includes peripheral components in the vehicles as well as central components in the operational control center (OCC) and the planning department.

Inside the vehicle the following components work together (Figure 1)::

- On-board computer with driver control unit
- DGPS-receiver, radio for on-line data transmission and voice radio
- WLAN for off-line data transmission
- Optical and digital announcement subsystems
- Automated passenger counting system (APC)
- Door criterion and distance sensor

These components provide the following system functions:

- Automatic vehicle location based on distance sensor, door criterion, and DGPS-data,
- Identification and display of time table deviations,
- Processing of radio data and voice radio transmission,
- Control of the IT-subsystems in the vehicle, e.g. ticket machine, interior and external displays, digital announcement, prioritisation at traffic lights
- Emergency transmission with automatic position information.

Integration with the Real Time Passenger Information (RTPI)

The real time data can be made available for the passengers. The system offers several possibilities of presenting real time data:

- With a wide variety of displays at stops or at points of interest
- With data services via GPRS (public mobile radio) directly to the mobile phone
- Via internet
- Via displays of third parties, e.g. parking ticket machines
- Via multi modal screens in shopping centers

The RTPI system gets the planning data, which is regularly updated by the AVM system.

The display shows the real time data specifying when the public transport vehicle leaves the stop. The display shows the following information:

- Line and destination
- Time till vehicle departure in minutes
- (Optionally) The platform number

Benefits of AVM and Passenger Information Systems

AVM and RTPI systems have internal and external orientated benefits.

Internal orientated benefits are - among others – the following:

- Real time data for more detailed, reliable and efficient planning processes
- Online information on traffic congestions
- Automatically generated management reports based on a wide scale of operational data
- Analysis and certification of service quality level
- Access to online data with coordinates in case of emergencies

- Automatically collected online data on (technical) malfunctions
- Anytime up-to-date overview about all services in the OCC (reduction of mobile supervision personnel)
- High quality supervision of the drivers
- Integrated system concept with central data input and automatic data transmission to all other applications.

External orientated benefits, visible for passengers, are:

- Dynamic protection of connections within own services / own network
- Dynamic protection of connections with services of other companies, e.g. bus – metro or train – tram, (in case of an interface between the AVM systems of the different operators)
- Provision of real time data for the passengers at stops, in malls, via displays and via mobile everywhere

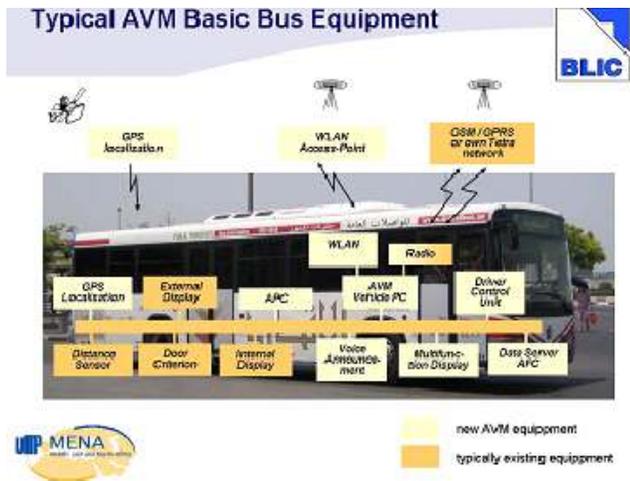


Figure 1 – Blic Gmbh suggestion for AVM components on vehicle.

But like all the other solutions in production, the Blic solution is not complete. Some important points in the integration are missing. For example, they don't consider the integration of the intermittent corridor bus system in the central solution.

3. Proposed Solution

3.1. Solution Description

It is understandable that for these processes efficiency, and to "attack" the big problem, described before, it is necessary to embrace the solution to all kind of IT systems and to the management and sharing of the different kinds of information (theoretic, planned and real), being essential the integration between the systems.

Many researchers had putted their attention on this solution, like Giannopoulos and Tyrinopoulos (1999), that demonstrated that it is in the public transportation sector that systems integration is more preponderant, because, in this sector, the operators typically invest on different applications of distinct functional

domains, creating a generated data volume of different sources. The interoperability and the interconnectivity between those applications and the data sources are important goals to achieve for the maximization of benefits for public transportation operators [3].

For this reason, it is proposed a unique centralized solution (with net control and monitorization, positioning, events, ordering, passengers counting, video surveillance, information to the passenger) with interfaces with external systems, like embedded systems and mobile solutions. A multiservices platform, that can integrate an IT systems panoply of last generation (figure 2), based on the critic analysis of qualities and deficiencies in the existing "state-of-the-art" solutions.

3.2. Proposed Architecture

In figure 2 are planned the systems, applications, technologies and interactions of the proposed solution, that at the same time, demands the installation in each vehicle.

Legend of the Figure 2:

- 1 System of Signaling and Priorities Management.
System that enables the automatic or manual management (controlled from the central control) of signaling, messages of the electronic panels of the roads, with the ability to detect a vehicle and confer him priority of passage, safeguarding the time of travel and the resulting customer satisfaction.
- 2 System of Passengers Counting
A system that enables in each stop and in each vehicle equipped with technology and passengers tally mechanism, the capture of important information for central control, enabling a better management of the regularity and support to the decision in the definition of the theoretical and planned services.
- 3 System of Corridor Bus Vigilance
System that enables the detection, notification and automatic alert of the authorities of road destined to vehicles authorized (the buses in a Bus Lane for the case of road transport). The system even allows registering and identifying in real time the offender vehicle through a camera installed in each vehicle.
- 4 System of Ticketing
System that enables the electronic registration and payment of sales and invoicing in each vehicle. Not being information "discharged" in real time for the central system is important information to integrate for the consistency of the whole process, as it was justified previously.
- 5 System of Passengers Information
System that allows dispose, in a quick, accurate and with quality form, all kinds of service information to passengers by various means (Web portals, mobile devices, information panels).
- 6 System of Parks Management

System enables that each crew member know in advance in which place and in that which should park its vehicle. Of the various technologies available to support this system, the choice of the best one is dependent on understanding the context and the customer in question, namely it depends heavily of the size of the park, of the fleet, the amount that the company is willing to invest, etc.

- 7 Management of Operations System
A system that encompasses the full range of modules for management, monitoring and control operations that involve the transport service. It represents the central system interface and the command center for all operations. Includes GIS systems, AVM, SGM, SGE, SGO, SGV.
- 8 Alert and Safety System
System that enables early warning of the authorities in cases of incident, accident, malfunction. Also alerts in an automated way the crew of the dangerous proximity of another car, to prevent accidents and help to drive safely.
- 9 Intermittent Bus Corridor System
A system that allows control the opening and closing of bus lanes by the control center or by a program set up by them. Typically supported by a set of LED's, which when activated indicate the closure of the corridor.
- 10 Video-Surveillance System
System that enables real-time video surveillance of each vehicle by the control center so it can act immediately in case of detection of any incident or situation of insecurity, in some systems the video images are just automatically transmitted to the control center after alert of crew [4].

In the proposed solution all this information coming from different systems is crossed and integrated in the central system that persists, manages and analyzes that essential information in supporting the decision of possible subsequent replanning of schedules, services, budget, maintenance and purchase of equipment, evaluation of staff and so on.

All these systems must be integrated into a flexible and adaptable platform to the whole environment (urban, rural and interurban) and means of land transport (road, rail and subway). Being that it is necessary to consider the different requirements and applicability of the solution to every transportation environment.

4. Implemented Solution

The solution comes to strengthen SmartCities Operations's offer, bridging the missing components with the integration platform capacity expansion with passenger counting and priority systems and with the introduction of GIS module and the regulation management and the spreading to mobile solutions.

4.1. Data Model

It is an economically accessible solution, based on the communication between a mobile device equipped with GPS and the central solution. According the Bernstein Research[4] study, made in February of 2007, it benefits over the technological global strategies which focuses on location-based services for cellular networks, in Europe and United States of America(USA), the introduction of integrated GPS receptors on mobile devices, like PDAs or smart phones is around 2% in Europe, the 30% in Japan and Korea and 50% in the USA. The expectations of adherence to these devices are also positive signs that the supply of mobile devices with integrated GPS receiver for around will be between 29% and 46% of total mobile devices available worldwide.

This solution is however subject to human error, depending on the crew in the notification of arrival at a node, as well as the location of the error GPS, available worldwide.

In the model were introduced location geo-reference, trip concept and necessary support for passenger counting and priority systems support.

This data architecture represents a bunch of concepts e and relations between them represented in figure 9.



Figure 8 – New components of data model. In red are the ones already existent in the platform.

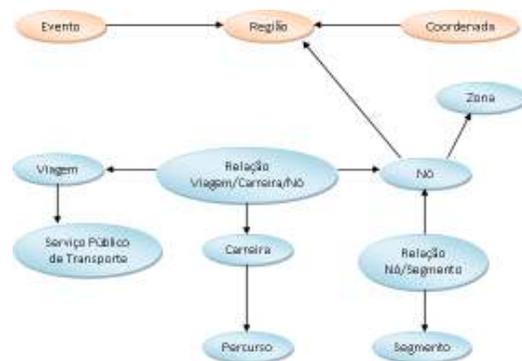


Figura 9 – Conceptual model. In blue the concepts related with the regularity management and in orange the geo-reference model.

4.2. System Functionalities

As a main requirement it was defined from the beginning, for all the components needed to be developed for the solution, the integration with the already existent platform. So it could be defined a final solution, complete and integrated, close to the proposed solution.

4.2.1 Regularity administration solution

For the regularity administration component, it was collected a group of typical functionalities of the present systems, and related on table 1, with the functionalities of the implemented solution.

All of these collected functionalities were considered as requirement of the regulation component to implement. Some of them however, very dependents of the electronic component, of the equipments in the vehicles, that depends on other parts for its possible implementation, and for that reason defined as future work.

The following describe the main functionalities of the implemented solution

- Spine monitoring.
The defined course by the user can be configured by the same to be presented in spine. In that case the course is displayed in the vertical and each course is represented independently, in other words, of a knot belongs simultaneously to X courses he is represented X times (Figure 3).



Figure 3 – Spine model of the regulation management module implemented

- Net monitoring.
The defined course by the user can be configured by the same to be presented in net. In that case the course is displayed in the horizontal and each knot is represented independently, in other words, if a knot belongs simultaneously to X courses he is only represented once, corresponding to an intersection point among the 2 courses (figure 4).

It is possible to dynamically change among a net and spine model.

If no represented is selected by the user, the system has in account pre-defined configuration for each course (defined in the data base) for that case the user can configure each course for a cascade or diagonal representation.

- Diagram filter (agile).
It is possible to dynamically filter the diagram, for the exclusive representation of certain courses of a certain bus. By default all the courses that belong to bus with planed trips for the day are represented (figure 4).

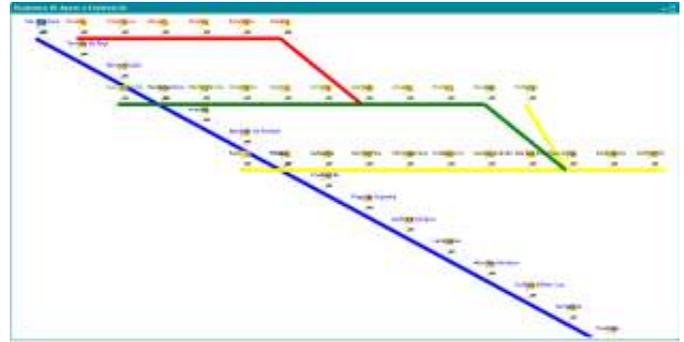


Figure 4 – Net model of the regulation management module implemented

To support the central regulation solution an application was implemented for mobile devices (figure 5). That is justified for being a solution that for its characteristics, can enlarge the range of costumers of the platform to small operators



Figure 5 – Application for mobile devices implemented

4.3.1.2 GIS solution

For the location and geo-reference component it was collected a group of typical functionalities of the present systems [5] [6], and related on table 2, with the functionalities of the implemented solution.

Also for this component all these functionalities were considered as requirement of the component to implement. The GIS component in this phase was implemented in the solution for the geo-reference of places and representation of real time events, and not as a fleet management tool in the vehicle location in real time. For that reason, some of the requirements enumerated previously were defined as future work or even ignored.

The following describe the main functionalities of the implemented solution:

Geo-reference of events on a cartographic map

From the SGO, after specifying the name of the place of a certain event, the system when triggered locates that place automatically in a cartographic map and represents the area of that place (figure 6).

Definition of events regions.

From the SGO, directly in the cartographic map it is possible to define representative areas of the event (figure 6).

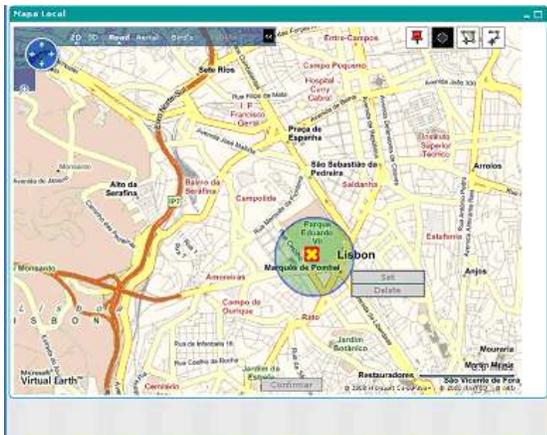


Figure 6 – Geo-reference component e definition of areas implemented.

Global map

Starting from the GIS module, is possible to visualize all of the events that were still not closed, together with its description (figure 7). It is also possible the addition of traffic events.

All the zoom, pan, auxiliary minimap to the navigator and different views (Aerial, roads and birdseye) functionalities are contributes of the used technology (Virtual Earth API v6.0)

If in a place exists more than one open event, the area is marked with a darker color.



Figure 7 –GIS component of the solution

5. Results and Conclusion

5.1. Conclusion

The central problem of the disintegration of the public transport system, is well recognized by operators and by the institutions

and companies from electronic equipment and software associated with the transport sector.

And there exist several attempts at different levels to try to solve the problem:

- At the model and data interface level. With the definition of architectures and formats and interfaces for data standards..
- At the institutional level. With the meeting, organization and partnership among various stakeholders in an attempt to find answers to solve the problem together and unify the vision of the problem by all parts.

The fact is that the solution was never found, because the existing solutions are geared to solving a particular problem of the client. Typically solutions are not extended and characterized as being "stuck" in a technology, application and/or equipment in concrete, which hinders the integration with other systems, which reveals the lack of an overview of the problem by the business software.

This study provided some contributions to the vision and complete analysis to the problem, the main ones are listed here.

5.2. Contributions

The work represents an important scientific contribution, to research, critical analysis and solution developed on different perspectives to the key issues of this area.

They are then followed for the synthesis of the major contributions of this work, described throughout this document:

Development of a data model to support real-time monitoring integrated with information from other systems integrated into the platform.

Design of a central solution independent of the equipments, where all the relevant information is channeled to manage real-time activity of the operator.

Creating a solution that gives an higher flexibility to the operator in the choose of equipments, that are the main cost of a project with this dimension.

Namely, the operator can benefit with the possibility conceded to him to choose for open-source technologies.

Solution developed extends to a range of clients of smaller operating companies, with developing the capability to support the interaction of the system with new equipment, cheaper and accessible to these companies, such as PDA. As an alternative to on-board computers or other equipment installed. Some operators are not owners of some of the cars in its fleet, renting them to other companies, and in that context, cannot equip vehicles. The solution developed also extends the offer to these operators. In addition, the management of regulation through the interaction of the system with a mobile device in an interurban is the most appropriate alternative.

Geo-reference of local and ability to represent them on a cartographic map included in the platform that allows real-time channel all relevant information from other systems for monitoring of events on the map.

Integrating the platform of a set of new technologies capable of giving the same ability to extend the new features and richer interfaces.

5.3. Future Work

The work presents a further contribution to the management systems in real time however there room for some improvement, and to highlight:

Development of the possibility of integrating new functions to the management system of regulation, with the exploration and development of its integration with metering system for passengers, both inside the cars (SmartBus) as the stops (SmartStop). Particularly with the combination of integration to alert, conferred the ability to obtain more accurate indicators, in less time and in an automated way, allowing a better management of regularity and even as decision support in the definition of theoretical and services planned. The data model has been prepared for the integration of the system developed with a metering system.

In this context would also lead to many benefits the introduction of new rules for the management of regularity, such as:

- In the context in which a vehicle carrying a number of passengers below the minimum number required by rule, are reported to the driver of an automatic, semi-automatic or manual certain instructions, which may include instructions to:
 - Misuse of the route and change the service in general;
 - Collection of the vehicle, among others.
- In the context in which a vehicle is full (or carries a number of passengers above the maximum number imposed by rule) and secondly the vehicle that precedes the same route carries a number of passengers below the minimum number required by rule, are reported to the driver, in the same way, certain instructions, which may include instructions to:
 - The slowdown of the vehicle with more seats left (to increase distance between vehicles in an attempt to divide the number of passengers);
 - The overrunning of the vehicle with more seats left to the manned vehicle to collect passengers in following us, among other possible directions.

In order to improve the definition of rules and consistent instructions to drivers, you can also consider the intersection of information beyond the details of location, the number of passengers on each trip and each node and the time of service;

as details of the history of maintenance and service of vehicles, congestion and impediments of the tracks, among others.

The rules of business, then allow the central system a management more efficient of resources and better control of operations in general and in particular regularity.

- Restructuring of the protocol of messages to include in the arrival message the identifier of that and thus ensure that the platform always know, without risk of failure, which stopped the vehicle actually arrived. Thus, the order as the messages arrived to the platform no longer had any relevance and the risk of errors and inconsistencies in service would be substantially reduced.

Moreover, there is always the chance of passing data between the GPS coordinates sent in the arrival message with the coordinates of the location of several nodes and then deduct the node where the vehicle actually stopped. The dependence of the accuracy of GPS coordinates sent by presenting itself as a serious constraint to the latter solution.

Association between the regulation solution and the corridor bus surveillance and intermittent bus corridor systems.

The association between the systems could go through:

- Signaling the real-time segments (shown in regulation diagram) with runners bus assets (managed by the bus corridor);
 - Signaling the real-time segments (shown in regulation diagram) where the space of the bus corridor is breached by an unauthorized vehicle. With the possible association violated corridor of a video or photo of the car wasteful, captured and sent by the surveillance system at the very moment of transgression, and the association of automatic alerts, semi-automatic and manual by different means of communication to the competent authorities.
- Consider possibility of adapting the model data of the solution to a standard model, as the European format Datex 2;
 - Structuring of geographic information according standards as KML, GeoRSS and GeoJSON [7], taking up new technologies such as SQL Server 2008 that allows the storage of geospace information. Allowing instant and efficient loading of large amounts of information in digital cartographic map and easily integrate this information with other technologies;
 - New model and technology for definition of diagrams to support the operation, using a specialized program for setting diagrams and graphs (such as Microsoft Visio) and the consequent integration and loading of such schemes in the system. This new solution would allow the specification of the interface itself in a diagram and consequently greater flexibility and efficiency in the design of diagrams;
 - Development of new rules of business automatic, semi-

automatic and manual for the management system of regulation with possible integration of the system with a specialized technology such as JRules, ensuring greater extensibility and consistency to the solution.

6. REFERENCES

- [1] 1st UITP MENA Congress And Showcase: Providing travelers with a seamless journey in Public Transport, Andreas SHREI Managing Director, BLIC mbH, Düsseldorf, Germany, Dubai, 25-27 November 2007.
- [2] Advanced Public Transportation Systems The State Of The Art Update 2006, FTA, USDOT.
- [3] A Complete Conceptual Model for the Integrated Management of the Transportation Work, Giannopoulos and Tyrinopoulos (1999),
<http://www.ncetr.usf.edu/jpt/pdf/JPT%207-4%20Tyrinopoulos.pdf>
- [4] General Manager ASSTRA CCTV surveillance and other security enhancing equipment on the italian survey “Guido del Mese, ANM Naples, Novembre 2007.
- [5] GIS needs assessments and implementation plan, GIS Functionality Matrix, City of West Sacramento,
http://www.cityofwestsacramento.org/gis/resources/documents/GIS_Strategic_Plan/Appendix/Appendix%20III%20GIS%20Functionality%20Matrix.pdf
- [6] Enabling the IT Enterprise With GIS Functionality, ESRI, April 2004
<http://www.esri.com/news/arcnews/spring04/articles/enabling-it.html>
- [7] 3 Top Data Formats for Map Mashups: KML, GeoRSS and GeoJSON,
<http://blog.programmableweb.com/2008/08/27/3-top-data-formats-for-map-mashups-kml-georss-and-geojson/>,
Andres Ferrate, August 27th, 2008

Table 1 – Relationship between typical functionalities of a AVM and the implemented solution. The green circles represent implemented and red not implemented.

AVM	Solução Implementada	Observações
Identification of stops, segments and lines		
Variants of courses and schedules management		In spite of supported at data model level of the complete solution
Schedules and seasons management (imported or edited)		
Vehicle and driver in trip identification		
Service embarked management		
Advanced positioning (GPS + odometer + door opening + local synchronization with stop's panels).		Limited to the sending through the mobile device of the real vehicle position (latitude/longitude).
Real kilometer record		
Monitoring of the lines on cartographic map		Future work with GIS component integration.
Spine lines monitoring (synoptic).		
Chromatic advance/delay alerts (configurable)		
Interactive management of trips (Overflow, shortening, collect, etc.)		Future work. At this time it is only possible the interactive visualization of the data of the trip.
Transport times.		
Edition of pre-defined messages of and for the mobile device		
Integrated management of alerts (SOS type / Pedal).		Future work with addition of an alert button in the application of the mobile device
Collect of transport parameters (speed, brakes, accelerations)		
Integration with fare management system, with ERP and others systems (through middleware)		
Provisional model of times for passengers information		
Advance/delay monitoring in real time in the control center		
Integration possibility with safety forces (continuation through cartography of vehicles in alarm)		Future work with GIS component integration
Relatórios de exploração (velocidades comerciais e de exploração, tempos por paragens, veículos por paragem, etc.).		The platform contains a generation motor of reports. With the necessary data those reports can be created by the own user. In spite of the support at model level, the mobile solution is not to collect those data
High voice system (Free-hand).		Dependent functionality of the equipment and possible with

		mobile device
Group call's support		Dependent functionality of the equipment and possible with a mobile device

Table 2 – Relationship between typical GIS functionalities and implemented solution functionalities. The green circles represent implemented and red not implemented.

GIS	Solução Implementada	Observações
Pan and Zoom.		
Presentation of information layers in the map		
Report generation.		Already generated reports with information of events SGO (information that implemented GIS represents)
Query & Browser of graphics and images on the map.		There are only represented on the map events that respect certain parameters
Information storage and overlap techniques (buffer generation – overlay techniques)		The used technology guarantees the use of technique and the persistence of the information is guaranteed
Latitude/Longitude/Geo-Reference generator		Guaranteed by the used technology
Coordinates/Areas/Volumes/Sizes/Distances calculations		Future work with calculations of áreas and distances that can be interesting in this context of use of the GIS
Overlap of layers of information		Technology guarantees that hypothesis, but it was not necessary its implementation for the proposed objectives
Hyper-linking objects		
Dynamic substitution of graphics and text		
Research of information in the map		The map is centered automatically in the information to represent. Not necessary functionality
Import/Export of graphic data and text		

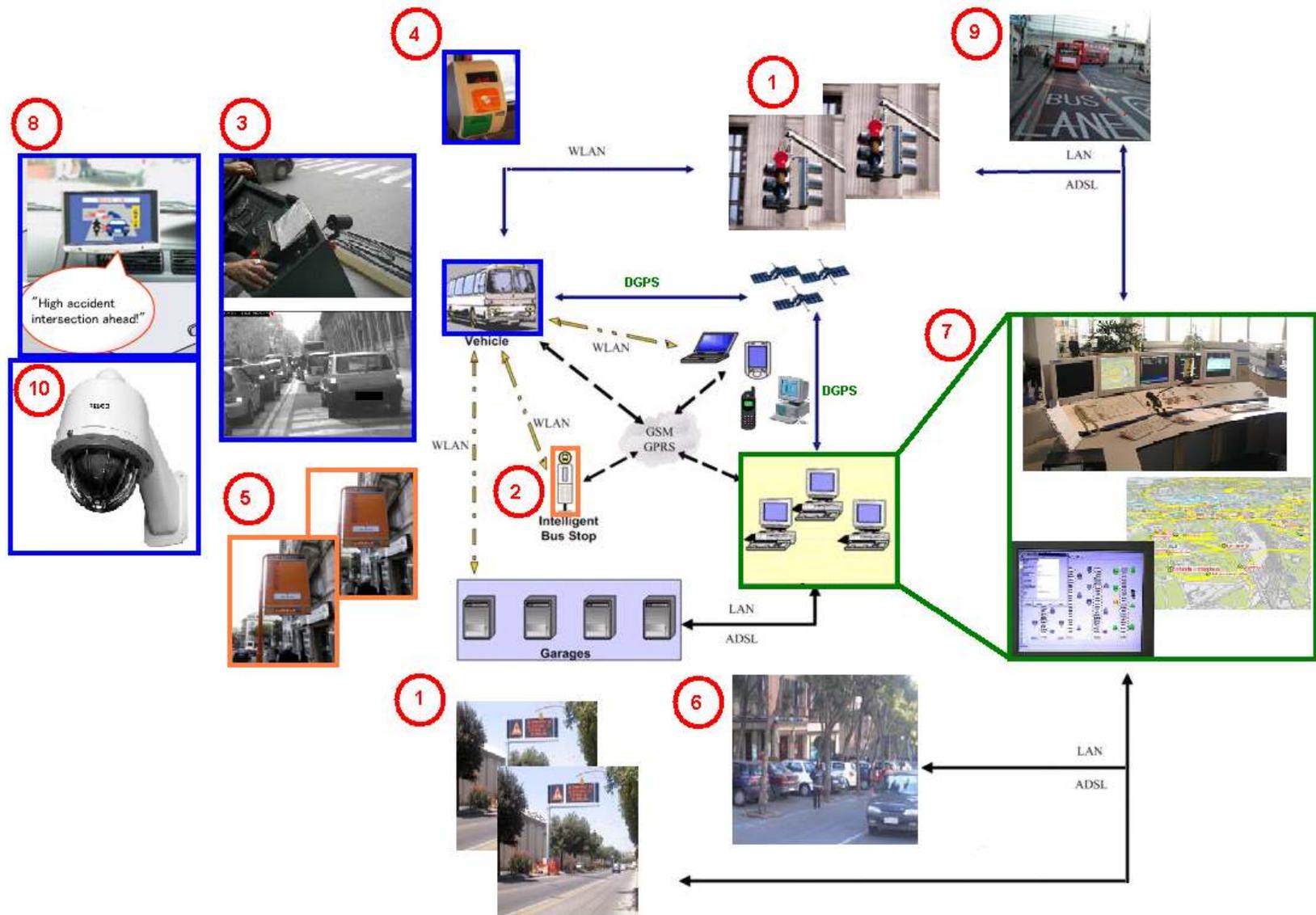


Figure 2 – Architecture of Applications and Technologies of the proposed solution for real-time management of passenger transport services.