The National Vehicle Identification System in Brazil as a tool for mobility improvement

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Summary — This paper presents the adoption, benefits and effects of a National Vehicle Identification System in Brazil in terms of its application in the areas of transport and logistics. The System, created on 2006, is still in implementation phase, but its pilot program has already shown promising results. In order to understand and verify the requirements of the National Vehicle Identification System (SINIAV) were analyzed the foundations established by the legislature and the subsequent regulation by the National Traffic Council. Also, given its appliance by SINIAV, radio frequency technology was analyzed in terms of safety and expected results. The importance of an open source technology for suppression of vehicle theft and robbery. SINIAV is expected to be deployed without any proprietary protocols and to allow data sharing between federal entities, which will benefit to public safety and mobility, thus becoming a qualitative leap for development of smart cities in Brazil.

Key words — radio frequency identification, RFID, SINIAV, identification of vehicles.

I. INTRODUCTION

Systems for Automatic Vehicle Identification (AVI) have been used around the world for more than a decade. Structures that support access, control and identification in general are applied in many different uses all over the world. The installations can be spotted at airports, seaports, bus terminals, bus-stops, taxi stands, centers of the cities, industrial and residential estates. Such systems are convenient to use due to solutions such as proximity or radio frequency access control allow easy registration of passing vehicles without need to delay their flow.

Another feature provided by RFID controlled AVI is facilitating security through automation of vehicle recognition and identification. Furthermore congestion, queues and miscommunication can cause delay and have a negative impact on business and the wellbeing of people.

Cities and business currently are investing heavily in infrastructure and facilities to increase security and mobility. Maintaining mobility is a challenge itself for city administration and business management. Meeting that challenge while conforming to new emission standards which become a vivid need of modern societies and thanks to use of control systems such as AVI is becoming feasible. Vehicle Identification Systems can help ensuring the speedy flow of traffic while contributing to a green environment [1]. Automatic remote detection prevents cars from standing still with the motor running. It prevents congestion and ensures swift and fuel efficient transportation of vehicles and goods [2].

Finally Automatic Vehicle Identification is much more than just vehicle control. Not only cars, but all kinds of vehicles can use such systems. Vehicles can be tracked as part of logistics or production processes. A lot of taxi queues are managed using AVI systems: through the identification of taxis the queue is managed and vehicles are allowed access to the passenger pickup area in the right order. Weighing bridges for trucks are equipped with AVI to automatically identify the vehicle and connect it to the weighing information before allowing the truck to proceed to the next step in the process [3]. All kinds of vehicles in mining industrial estates are tagged to keep track of them during the production process in the mines while ensuring high levels of safety. Trains are equipped with AVI to identify them entering and leaving train stations and keep track of them while performing their duty [4]. Even a lot of bus terminals are managed using AVI equipment.

In the future AVI will be actively used in fleet management to track vehicle location, hard stops, rapid acceleration, and sudden turns using sophisticated analysis of the data in order to implement new policies (e.g., no right/left turns) that result in cost savings [5, 6, 7].
Brazil has a fleet of more than 86 million vehicles, of which about 2.5 million are trucks. There are registered more than 7.5 million vehicles in São Paulo. Rio de Janeiro has about 2.4 million vehicles, while the fleet of Belo Horizonte is estimated for about 1.6 million and the Curitiba is now close to 1.5 million [8]. The territorial extension of the country together with the number of vehicles generate security and control problems, as well as complicates supervision of traffic and cargo transport on highways and urban roads. The theft charges [9], especially of electronic products, has been increasing, and in some places becoming serious issue [10]. Moreover, major cities suffer from congestion and lack of precise interventions to promote improvements of mobility and thus diminish the environmental, economic and social costs [11] e.g. time lost in traffic [12].

At a time when concepts of smart [13] and sustainable cities [14] are established, more efficiently integrating citizens to the management process, it is necessary to promote such integration with the use of technology [15] such as the Intelligent Transport Systems (ITS) which are already a reality in Brazil promoting advances in mobility.

The National System for Automatic Vehicle Identification (SINIAV) presents itself as an solution the existing problems in the areas of security and mobility, increasing the use of technology in vehicles and enforcement activities, ensuring at the same time, a preserving fundamental right for citizens and improving public management. This paper aims at analyzing the role of SINIAV as nationwide ITS, highlighting its objectives, the technology linked to its implementation and expected results, as well as proposing new use of information in urban mobility context, the information to be produced by the system when effectively in operation.

II. INTELLIGENT TRANSPORT SYSTEMS (ITS)

ITS are set of advanced applications which, without embodying technology as such, aim to provide innovative services related to different modes of transport and traffic management. According to the Brazilian National Public Transport Agency, ITS "mean multimodal control centers and operations, advanced traffic signal systems, monitoring systems and remote surveillance (cameras, sensors, probes, software), parking management, management of traffic incidents, emergency response, electronic payment, dynamic pricing and user information in real time "[16].

Initially, ITS technologies were designed to solve specific problems. The problem of speeding on public roads can be circumvented by deploying radars for surveillance that will allow capturing the image of the vehicles, and applications enabling panelizing the drivers. Closed circuit cameras which monitor vehicle flow on the roads of cities and enable quick intervention of agents where accidents occur. The traffic lights operating with fixed or real-time time schedule. In the latter case, they are sensitive to the amount of vehicles circulating and tailor its commands to the direction of increased flow through data collected by the controller reprograms for the central computer which sends the traffic signal time new rules to the controller. The collection of bus fares of public transport has benefited from the deployment of tickets and electronic turnstiles, reducing considerably the system of financial losses and facilitating passenger embarkation process. Buses are also equipped with cameras and automatic vehicle location systems (AVL) in order to enable the monitoring of passengers, travelling time and speed of the vehicle. Moreover ITS is used in number of other ways in context of transport and transit.

However, it is worth noting, that the intelligence of such systems should not be restricted to isolated solutions, which do not communicate with each other. The intelligence of these systems, at present, is in its design that ensures its own evolution, flexibility and integration with other systems. It can be achieved in number of ways, one of them accepted both in academia and public administration area, are open protocols that enable the connectivity, interoperability, ease of component replacement, the expansion of competition and cost reduction. The National System for Automatic Vehicle Identification, which will be described below, can be classified among the ITS which meets abovementioned standards.

III. THE NATIONAL SYSTEM FOR AUTOMATIC VEHICLE IDENTIFICATION (SINIAV)

The development of a system for the identification of vehicles, on national scale, was approved by the Brazilian Legislature for more than a decade. Supplementary Law No. 121 of February 9, 2006, created the National System for the Prevention, Control and Suppression of Vehicle and Cargo Theft and Robbery, aim to modernize and technologically adapt equipment and procedures related to prevention activities, surveillance and repression of theft and robbery of vehicles and cargo [17].

The federal entities, with the exception of municipalities, could then establish action plans to combat theft and robbery of vehicles and cargo throughout the national territory. The National Traffic Council (CONTRAN) has competence to establish the anti-theft devices and mandatory vehicle identification signs.

Thus, to identify vehicles, CONTRAN issued Resolution No. 212, on November 13, 2006 [18], later repealed by Resolution No. 412 on August 9, 2012 [19], establishing the SINIAV, based on the radio frequency identification technology (RFID), which should provide the transit executive entities with modern and interoperable tools for planning, monitoring and management of traffic and vehicle fleet.

IV. RFID TECHNOLOGY

The RFID technology to be used in SINIAV was began to be employed, in the 1930s, by the military in radars to identify objects. In the 1970s, it began to be used in the form tags for animal identification. In the field of mobility, the pioneer in the use of RFID was Norway, implementing an electronic toll collection system. This system has been replicated in various american cities up to the Rio-Niterói Bridge in 1996 [20].

Since that time number of other uses were given to RFID technology in the world. Noteworthy is the use of technology by large supermarket chains, retailers and industries to monitor the flow of their products [21]. Logistics, where the technology has been of great service to the traceability of supplies and products, either within or between industries and companies [22], in educational institutions [23] and cargo circulation by road [24]. Technological innovation increasingly sought by companies
that use tags, chips or Quick Response Codes - QR Code [25]. Agro business is also adopting RFID to control the chain of plant products [26], as well as other such as meet [27].

RFID is based on emission and collection of electromagnetic waves. For this process chips with data storage capacity are read by an external device and wireless technology are used. The reading may be restricted, but information can be also recorded, being of great use in automation processes.

The similarity of this technology to the barcode facilitates understanding how the RFID operates. In both cases there are readers and devices containing information, but while in the case of barcode the reading is made by an optical reader, the RFID reading is by radio signals via antenna or transponder [20].

SINIAV system consists of electronic identification device called "electronic board" installed in the vehicle reading antennas, processing plants and computer systems.

A. Electronic board

The electronic board used in SINIAV must be isolated and possess a unique and unalterable number and series for each vehicle, including information about unique serial number; vehicle license plate number; vehicle category; type of vehicle; foreign fleet vehicle.

The minimum storage capacity of the board must be 1024 bits and provide information necessary to operate the system in accordance with the memory allocation map defined in Annex II of Resolution No. 412.

B. Antenna

The Resolution No. 412 defines the antenna as the aggregate device software and firmware, responsible and able to read and write information on the electronic board. The antenna must enable integrated communications operation, and allow the reading of the electronic board installed in vehicles that are at any speed within the range of 0 to 160 km/h.

The safety of data transfer between the electronic board and antenna reader must ensured by the use of encryption keys recognized by the National Traffic Department (DENATRAN), with the consent of CONTRAN.

C. Processing centrals

As for the definition and characterization of processing centrals of SINIAV the Resolution No. 412 does not define it. Just as the previous resolution on the matter, there was an indication of the central between system components without having any explicit rule for its implementation and operation.

D. Computer systems

The early deployment of SINIAV in the States and the Federal District presupposes the existence of a reading equipment, registration and active supervision and its connection to a computer system for recording data of the electronic boards, connected to RENAVAM system.

Systems, information antennas and servers that are interconnected, must have security system that maintains the integrity of its specifications and content.

E. Protocols

In the Resolution No. 412, the CONTRAN determined that the protocol used for communication between the electronic board and the antennas cannot be proprietary.

The Brazilian Technical Standard specified in Annexes of the Resolution should be followed or, in absence of that, the International Technical Standard similar or equivalent in order to ensure the interoperability of the system throughout the national territory.

V. HOMOLOGATION OF EQUIPMENT

The devices of which the SINIAV system will consist of must be approved by the highest traffic executive of the country in accordance with the technical characteristics specified in Annex II of Resolution No. 412 and in particular Ordinance of the highest traffic executive of the country, with the consent of CONTRAN.

Even during the validity of Resolution No. 212, the DENATRAN published Ordinance 570, on 27 June, 2011, which establishes rules and defines the minimum requirements for certification and homologation of the products used to build the National Automatic Vehicle Identification System - SINIAV [28].

VI. IMPLEMENTATION AND OPERATIONALIZATION OF SINIAV

Resolution No. 412 imposes on the bodies or entities of National Traffic System (NTS), the responsibility for the implementation and operation of SINIAV within the limits of the powers assigned to them. DENATRAN, the highest traffic executive entity in Brazil, will be the developing, deploying and operating the computerized system and national database, which integrate the computer systems and local databases, as well as determining the specification of technical requirements of the system, storage and transmission of information, the frequency of databases updates and transmission of information, especially regarding the security.

At the state and Federal District level, the organs or transit executives entities should perform the installation of the electronic board in vehicles and their registration in the national database of SINIAV and RENAVAM.

Municipalities, organs and SNT members entities, will have obligation to integrate their systems to the national database of SINIAV, directly or through agreements with other agencies or entities SNT members. However, public bodies and entities which are not part of the SNT, within their authority, can be incorporated to SINIAV, through an agreement with agency or public entity member of the SNT.

Resolution No. 412 allows private companies whose line of work is set by the highest executive transit entity of Brazil and which express interest in SINIAV, integrate to the system through organ or member of the SNT entity but does not allow full access to information.

Private companies will have access only to vehicles owned by them or whose owners have authorized such access.

According to Resolution No. 131 on 9 December, 2012, of CONTRAN the implementation process of the SINIAV, should have started on 1 January 2013 and be completed until 30 June, 2015.

VII. DATA BASE AND CONFIDENTIALITY OF INFORMATION
The SINIAV system contains data of passing vehicle passing and exceptionally other data. The record of the vehicle passing next to the antenna will be sent simultaneously to local and national databases and should not contain or store information which makes it possible to identify the vehicle owner.

As the exception in the database will be registered vehicles of undocumented circulation or with some kind of restriction. Only the systems provided by the highest traffic executive of the country may feed the database with the exceptions, this action will be forbidden any other means.

The exclusion of the record from database will be made only by the proper organ. The registration of monocoque, engine and plate number will be made by RENAVAM in the exception database, can only be made when demonstrating the need, effectiveness and security according to DENATRAN criteria.

Resolution No. 412 was expressed the confidentiality of information obtained through the SINIAV system, which must follow the terms of the Constitution and the laws on the matter. This information is for use of public bodies and entities that comprise, for the purposes and powers conferred on them.

VIII. SINIAV PILOT PROJECT - DETRAN-RIO DE JANEIRO AND SEGULL COMPANY

The pilot project performed by the DETRAN RJ and Segull, brought together representatives of national bodies and entities as well as the representation of the State of Rio de Janeiro. The project ended on 30 April 2011.

The work proceeded in accordance with the legal provisions of SINIAV and their technical requirements. The following components were used:
- control center installed in DETRAN-RJ – which simulated actions of DENATRAN and DETRAN;
- emission station - where electronic boards of SINIAV were recorded;
- verification station (checkpoint)- installed at the exit of emission station;
- supervision station (checkpoint) - installed on existing fixed unit;
- movable supervision unit- with antenna reader, equipment of optical character recognition (OCR), movable computer and communication via global system for mobile units (GSM) with central control and IP camera for closed circuit television (CCTV);
- 120 electronic boards provided by the Wernher Von Braun Laboratory;
- 112 vehicles.

After performing all tests and procedures, assessment of each step was made. The conclusion on the system performance was satisfactory what opened way for future deployment of the system.

CONCLUSION

Villages, towns, cities and metropolitan areas are subject of theft of vehicles and cargo, movement of vehicles with cloned plates, the occurrence of accidents, traffic of dangerous goods and congestion. The problems are most severe in metropolitan regions where the flow is higher, but also demand a response in the peripheral municipalities where safety of the citizens is ensured.

The National System for the Prevention, Control and Suppression of Vehicle and Cargo Theft and Robbery was proposed as a security measure and enabled the design of SINIAV for the identification of vehicles with the use of the RFID technology, in all Brazilian states. The use of RFID is occurs in supplies and products control industry but also in the case RJ State experience presented above, which also shows the safety for traffic control and tracking vehicles and cargo, being a viable technology, safe and easy to apply in the immense field of Intelligent Transportation Systems.

As the relevant legislation enables municipalities to integrate data based on national SINIAV, either directly or through agreements with other agencies or SNT members, allow access, within legal limits to information for further studies and use for the planning of urban mobility, help in design and creation of other technologies and applications that facilitate monitoring of traffic and circulation of vehicles within cities.

The implementation of centers of urban mobility and public safety integrating the monitoring of events, the processing of traffic and transportation information and facilitating the rapid activation of the respective operational areas becomes possible and viable, especially in large urban centers, with the SINIAV implementation. Especially as the availability of information in real time, the use of open and standardized protocols for communication are required to the functioning of smart and sustainable cities.

REFERENCES


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