Proposed of ITS Specification for BRT

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Abstract: - In order to define a map of resources to users, operators, managers, equipment providers, application providers and other stakeholders, which can use as a guide for the implementation of its activities, it is used BRT, the Bus Rapid Transit (BRT) is an efficient transport system for cities that need to quickly expand your network of public transport, with a minimal investment compared to other systems. The BRT uses dedicated corridors to reduce user travel time, but these corridors should be within the existing road network, so it is necessary to implement automation systems that can coordinate BRT operations with other city transport modes. This automation system, known as ITS, has features that make this management, how to act at the traffic lights along the corridor in order to prioritize the passage of BRT, which also has other features in other areas that allow the proper functioning of the BRT.

Key-Words: - Map, BRT, ITS, Specification, Mobility, Transportation

1 Introduction

The development of medium and large cities and the growing need for fast and efficient urban mobility leading to implementation of a public transport system that meets the growing demand of the population. The BRT is a transport system that offers quality services at low cost and short-term deployment compared to other modes of transport. So many cities are choosing it as an ideal solution for mass transportation, meeting the daily needs of people for displacement in urban centers. [1]

The BRT concept consists of key elements to focus on the operation planned, adequate infrastructure, technology, effective management and quality service to passengers. These systems are essentially determined by: [8]

- Exclusive lanes and prioritizing bus
- Stations with prepayment and board level
- High capacity and embedded technology bus
- Distinct image
- ITS
- Integration of transport modes and

reorganization of existing lines

The implementation of a BRT system requires a lot of planning because of the various components that influence the process, such as the provision of service stations, vehicle configuration, bus interface to the system, information service to passengers and marketing, among others.

One of the BRT components is the ITS. The ITS system consists of a technology matrix intended for operation and management of urban mobility. It consists of a set of information systems, communication, control, monitoring, detection, agility and others. It aims to provide greater operational efficiency of transport and transit operations services, and provide comfort and safety for users of BRT services.

The main functionalities of ITS are: [5][6]

1) Path of previous information.
2) Information for the driver along the way.
3) Public transport information.
4) Personal Information Service.
5) Navigation and route guide.
6) Support for transportation planning.
7) Traffic control.
8) Incident Control.
9) Traffic demand control.
10) Political control and regulation of traffic.
11) Infrastructure maintenance control.
12) Improved visibility.
13) Automated operation of vehicles.
14) System for preventing longitudinal collision.
15) Prevention System against side impact.
16) Safe driving.
17) System of prevention and warning against possible collision.
18) Commercial acquisition vehicle control.
19) Control preferred for commercial vehicles.
20) Administrative processes of commercial vehicles.
21) Automatic roadside inspection.
22) Monitoring of commercial vehicles along the way.
23) Control and freight planning.
24) Public Transportation Management
25) Transport demand control.
26) Control of public transport systems integration.
27) Emergency Indication path.
28) Control of emergency response vehicles.
29) Notification of incidents and highly dangerous material traffic.
30) Financial transactions electronically.
31) Pedestrian Safety.
32) Signs for dangerous stretches.
33) Intelligent Crossings.

The listed features can be grouped in the various systems that make up the ITS and implemented on an architecture that allows for their integration. [2][3][4]

2 Problem Formulation

What ITS needs to achieve the BRT is complex because BRT is composed of several elements spread over a city, among them are: Stations, Shared roads, closed roads, buses and crews and maintenance.

The elements that need to exchange information with each other usually are not from the same manufacturer, so there is a clear need to integrate these systems and propose solutions to facilitate the implementation of any element within the ITS for the BRT.

The EDT system consists of several components that interact with each other, so that the STI are required to meet the needs BRT has a high complexity. However, each operator, regulator, government body, business and other groups have a form comprising the ITS for BRT.

This is not desired because it complicates the components and integration BRT activities, and sometimes acquire systems with the same functionality unnecessarily duplicated ITS functions to EDT.

To solve this problem, this paper proposes a mapping of ITS features for the BRT, it should be understood and as it fills all the actors involved in BRT, especially since this standardization allows each vendor to focus its development on their knowledge of the area, and facilitates the integration between systems.

For the government and regulators, this standardization facilitates discussion and allows you to properly prepare the specifications for everyone to understand the way the requested resources.

And finally, for the user to standardization allows it to have the same quality of service and complete understanding of what is using.

2.1 Implementation of ITS

The methodology to implement ITS consists to start from the architecture to implementation strategies for the project.

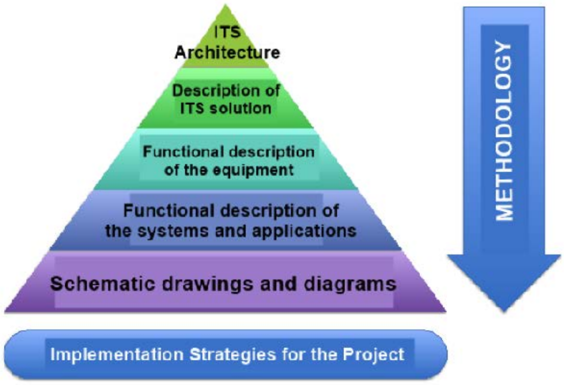

Fig.1: Development Methodology

Each step up the delivery of a document comprising:

- Step 1: Description of the ITS Architecture - Overview of ITS architecture;
- Step 2: Description of the ITS solution - From the architecture description, this document describes the proposed solution to the ITS project BRT Sao Jose dos Campos;
- Step 3: Functional description of equipment - This step is the functional description of the equipment identified in step 2;
- Step 4: Functional Description Systems and Applications - This step is the functional description of the systems and applications in step 2;
- Step 5: Drawings and diagrams Schematics - This step is the description of drawings and schematics for the ITS project;
- Step 6: Strategies for Project Implementation - This phase consists of the description of the implementation of ITS Project.

After definition of ITS architecture, it is necessary to start the description of ITS solution. This point start the problem due to lack of standardization, because the equipment and systems are different, so sometimes it is very difficult to make a multi-vendor solution for ITS.

Dependence on a single supplier makes the solutions remain proprietary and impede the evolution of the system, not to mention the expansions can cost more than they should.

3 Problem Solution

This item presents an initial proposal of functionality in order to standardize the understanding of ITS for BRT. This proposal should be discussed with all stakeholders involved in order to establish the same understanding for the ITS.

3.1 Actors of ITS

Following are presented the main actors that interact in the use of ITS for the BRT:

- Marketing and Access Control Agent: acts in a vehicle and / or other equipment connected to public transport (PT) services, responsible for marketing credits, for control of access and entry and exit aid users / passengers.
- Driver (PT): operates a licensed vehicle and linked to PT service.
- Operational Controller (PT): responsible for monitoring and control of PT's route schedules. Its activities include, in addition to monitoring and control, contingency measures and modification of routes and PTS supply in the course of operation. The modifications take into account abnormal situations, such as vehicle breakdown, the vehicle deceleration, adjustment needed to balance demands exceptional etc.
- Manager (PT): is the public or state, responsible for regulating and monitoring the PT services. It is a generalization of the actors regulator, planner, programmer and fiscal PT.
- Operator (PT): responsible for PT fleet operation, subject to the rules set by the manager, the programming of PT services and guidelines of the operating controller.
- Passenger: is an individual (or group), not part of the crew on board a vehicle during the course of a trip.
- intermodal service provider: set of operators from other transport systems, for example: metro, tramway, among others. Allows coordination for the efficient movement of people across multiple modes of transport.
- User: is all human entities that use, directly or indirectly, the services of the transport system. As the time and situation, this actor can be a pedestrian, commuter, passenger, driver (other non-system vehicles), tariff credit accounts or any other companies that take advantage of the services offered.
- Traveler: any individual who uses the transport services.

3.2 Planning, Programming and Management

The set of services that include, for example, the establishment of capillary level system and extension of the network, types of services, service and quality standards (indicators), generating work orders and carrying out the monitoring and management (monitoring and control) of operations of PT, as well as contingency measures, aimed at improving the adverse conditions to established standards.

3.2.1 Planning

The resource used to perceive reality, to identify in advance the demands and modeling scenarios, evaluate alternatives, structuring actions, routines and procedures established in order to satisfy the mobility aspirations of society and its main duties and established powers and define:

- Service standards and service quality: accessibility, levels of comfort, service integration levels, maximum waiting times (minimum frequency and commercial speed), quality indicators / performance and levels of prevention.
- Resources and infrastructure for the realization: planning the lines and routes, services and economic and financial analysis (income distribution, cost analysis and planning economic and financial companies).

3.2.2 Programming

Based on the planning and within the available resources, demand changes (daily and seasonal variations) and other external factors, carried out the programming of PT services, always seeking the best relationship between supply and demand, generating orders operational service (daily schedule), detailing:

- Amount and allocation of line for vehicles, often traveling time, itineraries, timesheet (timetable); and
- Allocation of human resources (drivers, sales agent).

3.2.3 Management

The management includes monitoring, supervision and control operation and functionality that performs monitoring and real-time control of parameters and events PT system, compared with the programmed, intervening when necessary in order to adapt the operation to set standards . It is understood as being adherent to the real-time features provided by the available infrastructure systems and data communication.

3.2.4 Measurement

Features associated with the collection, processing and visualization of information (parameters) about the vehicle and infrastructure (stations, terminals and tracks), necessary for the operation:

- Type 1 - embedded in the BRT vehicle: monitor the level of use and performance of the equipment and the way they are operated. Can contribute to the rationalization of equipment, provision of design, safety and comfort of operation. Examples: State monitoring (safety device, opening / closing doors) and as continuous variables (position, velocity, acceleration, occupation and motor functions / body).
- Type 2 - associated with infrastructure (stations, terminals and tracks): assess the level of congestion and occupation. Examples: the terminals and on the decks - users / travelers count; the roads - counting and identification of vehicles, speed measurement, light forward and improper occupation.

3.2.5 Monitoring and Fleet Management

It refers to the ability to efficiently manage the main inputs involved in the provision of PT services:

- Type 1 - maintenance and control inputs: functionality that focuses on the acquisition, storage and processing of information on the performance and level of maintenance and wear parts, parts and accessories (eg fuel consumption, mileage between failures) of vehicles. It may be important in controlling costs, preservation of equipment in reducing accidents / pollution and preventing failures.
- Type 2 - regularity, reliability and quality: allows control of equipment (operation and functioning), seeking to capture data reflecting traffic safety, passenger comfort and the way of interaction between the vehicle and the driver, provides data in order to assess driving the vehicle, allowing actions to correct or mitigate an inappropriate situation (eg speeding).

3.2.6 Monitoring and Management Services

It allows you to track the PT travel performance and carry out the management of the operation. Monitors and controls in real time the information of the PT system in order to provide principles and operation within predetermined parameters. The predefined parameters refer to the conditions under which the system should operate - obtained in the planning and scheduling of the operation - and that are subject to interference processes, which can be caused by factors such as weather conditions, events, functions, driver action, among others. comprising:

- Management and control of real-time operation: to maintain the regularity and reliability of services;
- Planned service verification (in the planned network) versus the service provided / performed (degree of operation); and
- Analysis and dynamic adjustment of supply over demand for station, terminal, drive shaft, etc. Means for dynamically adjusting any action in order to adapt the operation to an unforeseen situation, considering the available resources; allocation for example, extra trips due to excessive demand.

3.2.7 Control of Doors at Station

May be performed in the following ways:

- Type 1 - automatic control door opening: can help to increase the commercial speed and the operational flow while maintaining the timing of opening the doors of the stations with the TP vehicles when they are in proper positioning.
- Type 2 - use monitoring (selective / exclusive) way of the corridor: has the potential to monitor the use and curb the use of BRT lanes by unauthorized vehicles.

3.2.8 Critical Systems Independent

Systems designed to assist, automatically or semi-automatically, in operations that require a higher degree of precision and skill, aiming at the optimization of the operation (accuracy and speed).

3.2.9 Stops with Precision in Stations

It is used to align the stops for loading and unloading operations. In these operations, according to the system characteristics, there may be the need to do them more quickly and accurately to eliminate variations from different drivers' skill levels.

3.2.10 Automatic Guidance

In segregated routes may be allowed to drive and costing maneuvers (the pictures) more accurate and reliable without the need for driver intervention, except in emergency situations. The implementation of this feature may provide an improved design of BRT tracks (of smaller width bands) and an increase in the commercial speed of travel.

3.3 Electronic Charging

Set of services responsible for marketing credits, from generation, through distribution, validation and effective collection (ticketing) to compensation (clearing), enabling integration between different modes of transport.

3.3.1 Generation and Distribution

The electronic credit generation is the means by which it generates a lot of credits to be used by users for passenger PT on tariff payments. The claims of each batch will trace the long process of use. A lot of electronic claims may contain an expiration date, allowing, in closing, check the credits not waste used during the period of validity.

The distribution of electronic claims is the feature through which electronic claims are carried in the media to be used as payment in the PT system.

3.3.2 Validation, Collection (Billing), Passenger Count and Clearing

The validation of electronic claims is a feature in which the system checks the validity and the amount of available electronic credit being presented for payment of the fare. Designates also the permission the user, bearer of that credit has to use it and the conditions under which that credit is being used. This feature is important for the credit control by holders of benefits users being required to wear some form of identification, preferably, for example, biometric identification. The collection of electronic credits, also called the ticketing is the functionality that receives electronic credits used by the passenger to pay the fare, then the validation process. It is desirable that this present some form of backup in real time the information involved. Thus, it will become possible to recover from information on the amounts involved in that operation: batch identification, amount of credits and carrier user.

The passenger count is a feature in which is recorded the amount of passengers, grouped by vehicle or access control equipment, user type (paying or not) and, where applicable, kind of benefits carrier, as well as amounts paid for each of the identified groups.

Clearing or compensation is a feature in which the result of the collection is distributed among the PT system service providers. The rules and proportions of this distribution must be previously agreed between these service providers and the manager of PT and must be known to all.

3.4 Information for Users of Services

Set of services responsible for distributing, extensively, updated and effective static and dynamic information on the transport network and on services to users.

3.4.1 Before the Start of Trip Information Plan

It is intended to assist you in planning the trip. Allow it to exercise choice about the mode and / or faster and more efficient route and make decisions from the knowledge of the best path, the arrival forecast, the combination of modes of transport and the cost of travel. Most often refer to static aspects. Examples: lines (routes, scheduling, tariffs) of city / intercity buses, location of intermodal terminals and parking, transport services (subway, LRT, taxis), maps and fares among others. The information is provided to the user through different media, such as telephone, internet, conventional radio, cell phones, smartphones, television and interactive public terminals (kiosks at strategic points). This information can come from multiple sources (in addition to PT), eg tourist organizations, parking lots, urban transit and multimode operators (metro, tramway, bus, aviators etc.).

3.4.2 Information During the Trip

It is intended to assist the traveler / passenger who needs complementary information, in planning the trip. They are usually operational information (dynamic) that aim to assist the traveler / passenger to monitor and possibly modify the trip (changing lines, paths etc.), providing guidance on:

- Information to the traveler (just before the start of the trip) - eg arrival of the next vehicle or a particular line of service suspension. The traveler must receive this information when you are in the vicinity of the station, or within the same and can be transmitted to the boarding platform;
- Passenger information - eg the next season, the possibility of choices modes and connections and the estimated arrival (estimated travel time) based on historical data and these conditions at that time (eg traffic conditions, climate, existence of congestion, operational incidents, accidents, and other works). Other useful information for passengers are: sights, yellow pages and others. There are several ways this information be disclosed (specialized media), through voice messages via paging system; variable message panels - located at strategic points in the vehicles, stations, terminals and channels; special radio equipment; mobile devices such as laptops or personal units shipped, eg mobile phones (smartphones) and browsers.

3.4.3 Post travel information

Feature that aims to provide information on historical travel, such as Customer Service - SAC.

3.5 Health and Safety

Set of services responsible for providing greater security to the traveler / passenger / driver, both in the aspect of preventing the actions of third parties (security), and to guard against operational risks (safety).

3.5.1 Vehicles Monitoring

Consists of monitoring by embedded image, stations, terminals, stops, ticket offices, ordinances, platforms, roads and parking lots of PT vehicles. Can help to attract new passengers, it can provide a greater sense of security users.

This monitoring has different objectives, depending on the location of the cameras:

- Surrounding the station: it aims to prevent the action of criminals;
- Inside the station: in addition to the previous goal, the cameras help to control overcrowding, inappropriate behavior, unauthorized sellers, harassment, revenue evasion and investigation of fraud;
- Inside the vehicle: aim to provide more safety for passengers / drivers / marketing agents against fraud, vandalism and crimes (focus inside) and, more comfort in travel (focus on front of the vehicle, allowing the visualization of possible accidents);
- Towards (segregated): the cameras are designed to verify the existence of elements that might jeopardize the vehicle, driver and passengers in the travel route, as obstacles

and action of criminals. Prevent also against the track invasion by unauthorized vehicles and pedestrians.

- Alarms can be activated by drivers / users of PT and sent to central operations. Call (button) panic should be included in incidents / accidents treatment plans, eg transmission of image and sound, activated due to the activation of the panic button.

3.5.2 Control of Agglomeration

Monitors the amount of travelers and passengers present in the stations and vehicles, in order to determine the level of occupation in order to avoid overcrowding and discomfort. May use an imaging monitoring system to meet the goal, as well as turnstiles and automatic access doors to limit the flow of passengers. In panic situations, the turnstiles at entrances / exits should provide a mechanism to facilitate the evacuation (free passage).

3.5.3 Integration with Public Security Systems and Emergency

It is sharing of information, voice and image with the security and emergency forces in order to prevent and treat critical situations, risks to users and damage to the PT system, caused by offenders and criminals, vandals, weather conditions or accidents.

Can provide and use data from Police, Ambulance and Fire department.

3.5.4 Automatic Control of Doors

It aims to ensure the safety of users. Such functionality contributes to improving safety, minimizing risk of accidents involving travelers while waiting at stations and platforms, as well as when loading and unloading of vehicles. They may be used, for example, before crushing devices, positioning sensors, etc.

3.6 Multimode Coordination

Set of services responsible for the coordination of transport and traffic systems, to improve intermodal transfer services and prioritize PT traffic signal at intersections.

3.6.1 Integration between Modes

Allows coordination between agents operating in different services (intermodal service provider). Aims to provide convenience at the point of transfer, as well as improving the operation of the PT. Application examples: subway transfer to buses, ie transfer of a larger capacity system to another lower capacity where there is a strong need for preparation or timing.

3.6.2 Traffic Light Management

At intersections where there is an adaptive traffic control system, seeking to favor the circulation of the PT vehicles by priority at traffic lights. Establish channels of communication between the (s) System (s) PT operational control and (s) system (s) operational control of urban traffic, aimed at coordination between them, improving the performance of PT without degrading traffic.

3.6 Infrastructure Monitoring

Objective continuity of operation, maintaining the infrastructure and ancillary services, such as electricity supply, telecommunications, data processing and others. Should allow the rapid and accurate identification of problems, speeding up the solution through operating interventions and corrective maintenance, triggering the leaders and eventually effecting the activation of contingency plans. It allows even operate remotely critical systems - such as power supply.

Examples of equipment that can be monitored: turnstiles, automatic doors, vehicles, internal data networks, generators, nobreaks, air conditioners, computers, servers and others.

Another important function that can be added is the monitoring of external agents that cause risk or interference in the operation of the transport system, for example, weather conditions such as rain and lightning, flooding roads and stations.

4 Conclusion

The paper presented proposes standardize the mapping of operational procedures for the BRT in order to optimize and facilitate the understanding of any system. This way it can purchase from any vendor systems because everyone understands the same specification, reducing the understanding errors. This article presents a possible understanding for the features required for ITS and will serve as a basis to discuss and standardize the mapping.

The city of Sao Jose dos Campos became interested and supports the discussion to standardize the functionality and the applicable protocols in a BRT and are applying the proposed this article in its

BRT projects.

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