System Functionalities of Its for BRT

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Abstract: - The BRT (Bus Rapid Transit) is a public transport system with quality service and low cost that is being used in Brazil on a large scale. The quality of service is achieved through an efficient automation system, this system called ITS (Intelligent Transportation System), which allows control over the operating activities and maintenance of the BRT, but system complexity brings the difficulty in defining the necessary equipment and systems. In this context, the article brings to discussion the functionality of the equipment and systems that allow this warranty service in order to standardize for the BRT actors to understand each of these equipment and systems and achieve the best outcome for the operation of the BRT.

Key-Words: - Equipment, System, ITS, BRT, Standardization, Transportation

I. INTRODUCTION

The BRT system not only proposes a change in the fleet or infrastructure of public transportation. But rather a set of changes that together forms a new concept in urban mobility, because it is a mass transportation system for passengers that deliver fast, comfortable, safe and efficient urban mobility through segregated infrastructure with overdrive priority, fast and frequent operation, excellence marketing and customer service.

The implementation of high-performance transit systems, efficient and environmentally sustainable world consists of the political agenda of urban and environmental planners.

For this, there is nothing more appropriate than BRT solutions, achievable in the medium and long term with moderate investment. The BRT concepts are integrated homogeneously in urban structures, in a timely manner as full or also stepwise solution.

The main characteristics of BRT are dedicated corridors for the movement of public transport, loading and unloading of vehicles on the same level, making the process faster, high-capacity vehicles, modern and cleaner technologies, integration with other modes of transport, operational control center, prioritizing traffic signal, real-time information to the user, and so on.

The Bus Rapid Transit (BRT) is from one of the engines cost more efficient for cities quickly develop a public transport system that can expand a complete network as well how to promote a speedy service and excellent quality. Still in his early application, the BRT concept offers the potential to revolutionize the way of urban transport.

II. PROBLEM FORMULATION

An important component for BRT is the ITS. The ITS need to implement a sophisticated automation control in order to integrate all

components of BRT and to increase the quality of services offered by public transportation. The elements that need to exchange information with each other are usually not the same manufacturer, therefore 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.

Due to this situation the present article present the functionalities needs by the equipment and systems for ITS, in order to start the discussion for standardization. Certainly this is the first discussion and need to be depth in another discussions.

III. SPECIFICATION OF ITS COMPONENTS

This chapter present the system specifications of ITS components in order to start the discussion for standardize the functionalities of ITS for BRT.

A. Electronic Ticketing System (SBE)

The described system of electronic ticketing does not consider interoperability with existing systems. If necessary, the architecture should be reviewed to address this need.

Electronic ticketing is a set of related processes that allows to rate the use of public transport, if the BRT. The processes involved in this system are: User Registration, Sales Force Automation, Payment, Raising Tickets Rates, Accounts reconciliation and Management System.

According to the operational needs of the municipality, the sale and registration of users can be carried out over the internet, self-service terminals in the stations, mobile or authorized positions. To this end, the system considers the use of smart card to store the information of users and securely values. The user to enter the BRT or boarding terminal passes the smart card validators which are devices that verify the authenticity of the card and performs the output values stored on the card, and store the same usage history. Usually these validators are equipped with turnstiles to physically contain user input.

The Electronic Ticketing System also contains a call accounting software that is responsible for performing the management of rate, points of sale and all the equipment that make up the electronic ticketing system. This software is responsible for conducting a financial transaction between the entities involved in the BRT process.

The system also includes a system that performs the analysis and reconciliation of the data to ensure the security of the electronic ticketing process and provide historical information for analysis of transport conditions and so allows the CCO may set number of vehicles required, use of time, origin and destination, among others.

Finally, the SBE is provided a data communication system, which is responsible for data exchange between devices, software and systems securely in order to guarantee the operation of the SBE.

B. Support System Operation (SAO)

The supporting operation systems (SAO) consist of equipment, systems, platforms and services to automate, streamline and optimize inspection processes, supervision, operation, planning, support, monitoring and public transportation system management. These systems also allow cost savings and greater efficiency, transparency in the operation and control of services.

The SAO will systematically organize the data operations in the provision of services, enabling the creation of an information base and provide valuable data for operation by each concessionaire and the supervision and inspection of the transport secretary allowing cost reduction and cost rationalization. It will also allow part of this information base is available in real time or on a scheduled basis to users through each User Information System (SIU), increasing the convenience and quality of service.

The SAO's functional structure is based on three main blocks:

- System Automatic Vehicle Location (AVL) and Computer Aided Dispatch (CAD)
- Planning and Transportation Management Services.
- Surveillance Systems.

AVL/CAD

Are systems that facilitate the management of transport operations, by reducing the response time to an incident on the field, information about the operation of onboard equipment and systems (telemetry), support to drivers, providing updated information on the location of the bus to the central order for bus and operation of each dealership, and placement information of the state of buses in operation for users.

This system allows providing the following features:

- Monitoring and telemetry of the bus.
- Planning: statistics, historical data and information generated by AVL / CAD system.

- Remote access and control equipment.

Planning Services and Transportation Management

Are services that use the database of the public transportation system operation for composition features, sharing, planning and dynamic routing of trips, assisted driving trip, sharing the means of transport and modal integration, increased premises and flexibility in the composition of the travel movements and improvement of service.

Surveillance Systems

Are embedded systems or points of embarkation and disembarkation platforms and the integration of stations and terminals compounds alarm devices (emergency button), closed circuit television (CCTV), feedback and accreditation of devices and access used to improve the monitoring of internal and external physical spaces used by the transport system.

C. User Information System (SIU)

The user information systems are made up of equipment, systems, platforms and services to promote extensive, fast, up to date, objective and effective availability of information providing increased convenience, usability and user comfort in use services through the dissemination of schedules, routes, fares and information relevant to the system in real time or not, through various media, highlighting:

- Embedded Information Devices: as displays, variable message panels and speakers.
- Information devices on the Ground: as displays, variable message panels, speakers, digital cameras, CCTV, integration stations, terminals, places of shipment and landfall, checkpoints, among others.
- Additional media: as internet, smartphones, mobile, radio, television, call centers and IVR.

SIU may be used for the dissemination of institutional content, in addition to disclosing third-party content, and can provide the generation of additional revenue, for example, the resulting publicity. It can also provide information to other channels such as digital radio, IPTV and Digital TV.

D. Operational Control Center (CCO)

The CCO should be managed through predefined procedures to ensure a standard for all events that occur during operation. These procedures must be described, they are known to all involved in the management of CCO and conveniently available through this system. This system should also register all unplanned events that occur during the operation and follow up of your solution, creating a record of events that serve to statistics and revision of operational procedures.

The CCO and all systems involved in the operation should be environments with controlled access. Initially all the people involved in the operation, employees or third parties must have an identification badge registered on a system that will give you access to the building entrance and the only environments where it really should act.

The entrance to the OCC room should have a tightening in access, in addition to being monitored twenty four hours by CCTV, all employees and third parties must be previously registered and access should be by a registration badge associated with a biometric system.

All systems involved in the transaction should require operator identification (login) before starting the work, this is also true for embedded systems where the driver identifies the onboard computer to take the vehicle in stations where vendors ticketing identify the PDV equipment before opening a box etc.

E. Planning Systems, Operational Optimization, Control and Regulation

The BRT system depends on time synchronization, reliability, regularity and integrated operation across its network. The Operational Planning system plans the order, operation, driving, timesheet, performance, staff allocation, vehicle allocation, regularity, punctuality, etc. on-board computers for vehicles receive information of arrivals and departures at stations, gathering for garages, travel time between stations, etc. For this, the system requires integration with the operation of management systems, thus ensuring the fulfillment of all the parameters defined by him.

Are highly sophisticated software, based on the use of operational data in real time, with mathematical algorithms support and should be integrated / be part of the operation management systems and integrated the systems and AVL applications (*Automatic Vehicle Location*) deployed on buses as well as the ticketing systems, operation and monitoring.

F. Traffic Priority System

To expedite traffic is necessary to give priority to buses, but without disturbing the local traffic of other vehicles. So the SAO platform must have appropriate interface to allow, in the future, that any equipment or traffic controller, provide priority information of the bus system.

Operational data network should be extended to the garage responsible for the maintenance of vehicles and orders for the line.

The network must also be integrated into the Traffic Control systems in area or traffic management systems, integrating traffic signal controllers, VMS (variable message panels), CCTV systems and detection and surveillance, telemetry, etc., with the CCO.

The CCO, the traffic checkpoint monitors the operation making the necessary interventions suggested by the operating software and control to ensure compliance with the plan. On a large screen (video wall) the general supervisor and the other stations can monitor the position of all vehicles by reproducing the image of a synoptic map via conjunction with other images.

G. Security and Surveillance Systems

When security talks if the bus systems should be considered on two main fronts of security: The security of the data system and the safety of passengers.

Data System Security (

For data security should be considered in the transmission of data on clearing and authentication (held in conjunction with the Central System).

The implementation of these features should follow the general requirements already established as the technical and functional requirements set forth herein.

The communication and security module refers to the processes that will be developed directly by employees, platforms, systems, infrastructure and the equipment installed in buses.

Are part of this module assembly processes the data stored in the validators and transmission of data to the data center through the Communication Network.

Passenger safety

Information and video surveillance for the safety of users systems should be created. Communication equipment with CCO to monitor the operation, safety, signaling and general communication with users.

Supervisory positions are responsible for monitoring by closed system of CCTV on the road and in all seasons. The supervisory team coordinates a security team that ensures the full functioning of the stations, roads and inside vehicles.

The supervision station operators must have at its disposal a CCTV system that has coverage across the board and BRT stations and has at some points the ease of handling of cameras in terms of rotation 360 and approximation of the image (*zoom*).

This position must be integrated with the competent authorities of equity security or police force

H. Communication Systems

One of the key systems for the operation of the CCO, stations and BRT itself is the communication system that can be divided into three subsystems:

Communication CCO and Data Center

The communication between the CCO and Data Center must be made through private data networks providing service through optical fiber. These networks should be redundant where at least two links should be hired from different operators and that their paths are demonstrably different fibers between the CCO and the Data Center. A third link, the radio can be hired increasing system reliability.

After specifying the functionality of the systems can be set in the Executive Project, the bandwidth required for each of the links. This is important because we need to define standards for video systems which occupy a large bandwidth of the links.

Operational Data Network Corridor

To the fullest extent of the BRT corridor will be built an operating fiber optic network connecting the equipment towards responsible for communication with the vehicles in operation.

The network must also be redundant in both the optical fiber segment scattered by the way, as in wireless communications with the vehicle in operation, stations and garages. The wireless part can be done through a network Wi-Fi and have a minimally GPRS communications (or 3G) with fixed IP and contracted service level guarantees through a telephone operator and data as a contingency.

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controllers, VMS (variable message panels), CCTV systems and detection and surveillance, telemetry, etc., with the CCO .

Mobile Communication Systems

Communication systems for all system elements with the mobility characteristic, for example, vehicles and people.

I. Data Center

The data center consists of equipment and systems responsible for managing, storing and processing all data and information generated by the system.

The data center usually has, as a minimum requirement is energy self-sufficient, or should have diesel generators able to keep all connected devices independent of the supply of the power utility. Daily backups and preventive maintenance should be performed, usually off-peak hours to maintain the reliability and data persistence. It is also requirement, keep the datacenter backup in different physical address of the main data center, to the case of natural disasters or not, such as flooding or fire, the two plants are not destroyed and can restore the backup so the site is reestablished.

It should also provide a security infrastructure to ensure that unauthorized access will not be made to systems and operational databases, providing data and information through the "web" without jeopardizing the operation.

J. Systems Traffic and Transit Management

For traffic and traffic management systems must have the traffic signal priority along with exclusive lanes for buses, following the BRT standards. There should also be a traffic information system for the relevant local movement of BRT.

Systems must still rely on CFTV systems (Used to support the operation of BRT), vehicle identifier system and Inspection and Transit Telemetry systems.

To assist in the management, a system should be created, whose function is to provide a single interface to manage field devices via their existing control and management systems. The exchange of data between existing systems and this manager system would be through, for example, the use of all ITE / AASHTO Traffic Management Data Dictionary standard (TMDD) Center for Communications to Traffic Management Center or European standard DATEX II with Open Data Framework. For example, in the United States, the Center center (C2C) communications is used for:

- Providing event information (e.g., incident, work area, etc.) to other traffic management centers.
- Provide traffic and travel data to other traffic management centers.
- Help coordinate operations within a C2C network defined.
- Provide remote control of traffic control devices.

In this application, each of the control systems acts (or function) as independent management center traffic, responsible for performing a specific function (e.g., control of CFTV cameras, or PMV control signals, etc.). One advantage of using this approach is that it allows using different vendors to expand your system, rather than trying to integrate new devices in legacy management system. Another advantage of using the data patterns TMDD C2C or Open Data Framework (ODF) is that the individual data elements are neutral to the underlying protocol used to convey information to each subsystem management systems and, therefore, the secretary transport is free to choose any encoding and transport protocol (TCP / IP, DATEX, XML, etc.) that best fits the application.

K. Technological Systems for Stations

Technological systems for the stations must take into account the communication networks already provided in this document for the reception and transmission of relevant data such as the expected time of arrival in a bus line. The stations should be equipped with easy viewing panels during the day of the period (high brightness) so that you can view the data without worrying about the brightness of the place.

L. Data Communication Network, Voice and Image

Data communication networks, images and voice, are made up of two systems: the primary and secondary communication systems perform communication between the various systems and subsystems.

They should enable the transmission and reception of messages in voice formats, data and images in a bidirectional manner, with integrity checking of all incoming and outgoing data as well as the ability to: IP number is set, implementation of QoS (quality of service) mechanism , emulation of

private networks, network status management in real time implementation of verification and validation mechanisms of communication and data traffic packages.

The primary communication system should allow the use of at least two simultaneous or complementary communication technologies, e.g. GSM / GPRS / EDGE and digital trucking or GSM / GPRS / EDGE and WiMAX or WiMAX and WCDMA (3G), etc.

M. CFTV System

The entire line of BRT and its stations and terminals should be monitored by a CFTV system with fixed cameras and vehicles must have built-in cameras showing the entire length of the vehicle and a camera facing out of the vehicle showing the driver's vision.

You need to determine the pattern of each shot, and time keeps the same design for data links and images storage disk space.

Some fixed cameras should also be able to be moved from the CCO moving in one hundred and eighty degrees (or 360 degrees, depending on the function) and approaching the desirable object, and minimally two internal cameras station wagon and two outer cameras, in each direction of the line.

Fixed cameras should be spread on supports visually cover the whole 100% BRT line.

The system should offer the possibility and show all or certain images captured in real time or retrieved from a recording in an image database and are digitally available in real time to the CCO and integrated with the traffic control systems and CFTV systems city traffic covered by the system, especially in BRT's area of influence.

These cameras are used to help centers by observing the surface transportation system. CFTV devices can be used by centers:

- Check for a reported traffic congestion.
- Determine what assistance may be needed for the incident.
- Monitor the progress of incidents, construction and special events.
- Determine when the residual incident congestion is eliminated.
- Provide visual images to the public about the state of the track.
- Determine what types of emergency services need to be dispatched.

In this implementation, the system will consist of an interface in which the center operators can monitor existing and future CFTV camera installations. The icons of the cameras will complete a map showing the location of each place of existing and new camera. The system should be constructed so that new facilities cameras are automatically recognized.

The operator has the ability to control each camera through the system interface that allows access to all camera control functions, for she supported, including the following features:

- Selecting a predetermined view of an assigned camera.
- Moving the camera viewing position.
- Control the camera's focus.
- Control the camera's iris.
- Pan or tilt the camera.
- Control the camera's zoom.
- Provide a text overlay to the camera location.

N. Embedded Systems

The embedded systems consist of a set of software together with hardware inputs and outputs specific functions. They can be highlighted as the main embedded system equipment and systems responsible for:

- Identification of the instantaneous geographic location of the bus.
- Collection and transmission of information on demand.
- Monitoring of the vehicle on the ground.
- Telemetry vehicle.
- Operating data record.
- Communication with the driver and conductor.
- Communication with the Central Operations and Inspection and emergency services (Police, Civil Defence, Home Guard, Firefighters, etc.).
- Control communications system and information for the driver and user.
- Generation operating alarms and operation of embedded devices and systems.
- Embedded surveillance.
- Remote intervention in the vehicle and embedded devices.
- Management and processing of data generated by the equipment transmission and / or recording images.
- Data or audio when alarms are triggered.
- Ticketing system.
- Monitors multimedia.
- External displays.

- Automatic counting of passengers at the gates or turnstiles.
- Various sensors.
- On-board computers.

IV. CONCLUSION

This first specification of BRT features aims to initiate a discussion on the topic, but intends to standardize the understanding of the features that an ITS for BRT should have for that BRT can provide excellent services. Furthermore, this standardization allows the actors involved in the design, development, approval and operation can understand and unify the understanding of every feature and avoid misunderstandings that might interfere with the correct operation of the BRT.

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