Archives of
Transport System
Telematics

Volume 9

Issue 3

September 2016

Tram Depot Operating System as a comprehensive, integrated informatics system

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ABSTRACT

The paper presents the principles of the Automated System for Management Depot. ASMD system includes:

- Identification System designed to recognize individuals who enters into depot (marker RFID),
- Radio Data transmission system, dedicated fibre optic network,
- The place for dispatcher with terminal equipped with interface for dispatcher,
- Integration with: subsystem monitoring (CCTV), the position of replenishment of sand, under- track turning machine, position of the laser measuring of flat area on wheels and stickers on the wheels.

System constantly analyzes the situation of track and signals from sensors available. The system is equipped with a number of reports to the dispatcher. The elements of detection and device drivers track ensure safety in the class SIL3.

KEYWORDS: Tram Depot Operating System, Safety Integrity Level, Fleet Identification System, Traffic Control System, Depot management system, Traffic Control Terminal

1. Introduction

This paper presents a system developed in response to the requirements of end user City of Szczecin Tramway Operator used for the operating and monitoring internal depot traffic base on tram on demand flow related to each next day working plans in respect to thy needs and valid technical restriction due to tram maintenance plan.

2. Fleet Identification System (SIT)

2.1. General concept of system SIT

The main task for the SIT system is identification and location of vehicles (trams) in time:

- entry to the depot,
- passing through the measurement stations,
- passing through collision nodes.

Based on information from the RFID tags mounted on the trams, the system identifies the object and notes his current position at the depot. Information received from the vehicles and / or RFID readers is transferred subsequently to the SZZ, where on the basis of defined rules will be determined parking position of identified vehicle.

In the absence of proper identification of the vehicle depot employee have the ability to manually verify the number of the vehicle with a manual reader RFID tags (if the vehicle is equipped with an RFID tag) or on the basis of unique characteristics of the wagon (eg. side number).

Depot employee can also manually specify in the dispatcher application SZZ parking place (to modify an order determined by an automatic algorithm - Level 2 work Of SZZ) for an oncoming vehicle.

Information about the vehicles are identified by SIT granted to other information systems on. Reading tags (tags) RFID in the following areas:

- tag identifier,
- an identifier (IP address) of the RFID reader.
- time.

Fig. 1. Fleet Identification Sensor [own study]

For each rail vehicle are assigned at least two ID numbers. Each number corresponds to the physical tag ID / RFID tag, which is installed at the beginning and end of the vehicle.

In the case of the longest configurations also mounted marker and the central module of the trams. This solution will allow to unambiguously determine the position of a rail vehicle in relation to the switches and determine the direction of travel. RFID tags are mounted in the lower part of the tram between the axles, which will allow the practice to achieve the shortest distance between the reader and provide no access to third parties. Provided readers / antennas and RFID tags, are suitable for use in harsh industrial environments.

2.2. Network devices and trackside devices

Track-side and control cabinet presented in the drawing number 1 and number 2 :

Fig. 2. Box with automatics and network devices on field [own study]

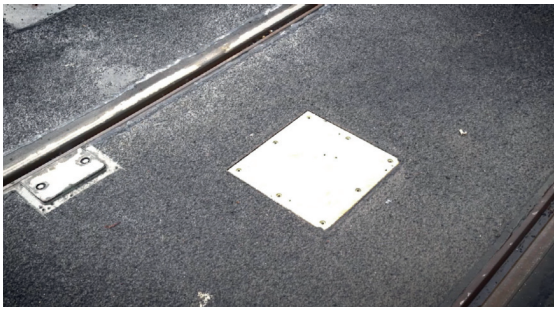

Fig. 3. Traffic sensor network devices on field [own study]

2.3. Network Management - dedicated fibre optic network, presented on drawing number 4

Fig. 4. Dedicated optical network [own study]

Integration with: subsystem monitoring (CCTV), the position of replenishment of sand, under- track turning machine, position of the laser measuring of flat area on wheels and stickers on the wheels.

Fig. 5. Integrated CCTV monitoring system [own study]

Fig. 6. Integrated device for laser measuring of flat area on wheels and stickers on the wheels [own study]

3. ASOZ System

3.1. System Architecture

The overall system architecture is presented in Figure 7.

The figure number 7 shows the key elements included in the Tram Depot Operating System:

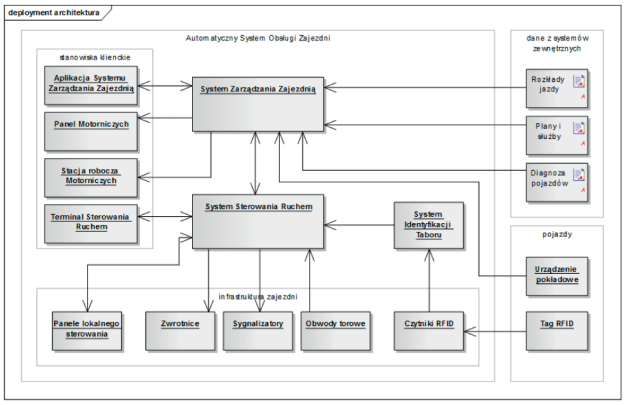

Fig. 7. The general architecture of Automated System for Management Depot. ASMD [own study]

Tram Depot Operating System (ASOZ)

This system automates the depot through the integration of each component and interface functionally integrated environment where data exchange occurs in a way that requires minimal user intervention. Also included are unusual situations in which some system components, in particular systems Traffic Control System (SSR) and Depot Management System (SZZ) are not available or are not working properly.

Depot Management System (SZZ)

Allocates parking space for vehicles to those entering the depot and guided trips. Allows management e dispositions repair and offering serviceability. It allows to the user visualization the state of the depot and provides reports related to the current functioning status.. Control and read the status of depot infrastructure is done via the Traffic Control System.

User interface for employees of the depot are:

- Application of Depot Management System - the client application serving management and control of depot work status ,
- Panel tram drivers - screen presenting information on. current grants trams drivers.
- Driver's workstation - a client application presents personalized information for the motorman after logging proximity card.

Traffic Control System (SSR)

SSR controls the infrastructure serving the movement of vehicles in a manner that ensures safety in SIL-3. This includes the entire infrastructure (automation) track is responsible for the movement of vehicles within the depot, and so mainly to control turnouts, signaling control, reading of the status of track circuits.

Use of Traffic Control System by employees of the depot are:

- Terminal Traffic Control (TSR) - used by the dispatcher to malfunction SZZ (ensuring control capabilities at damaged or disarmed SZZ system.
- Panels Local Control - located in the depot.

Fleet Identification System (SIT)

This includes infrastructure responsible for the identification of vehicles in selected places of the depot, so the proximity card readers RFID tags, RFID (tags) placed on the vehicles and the necessary cable connections.

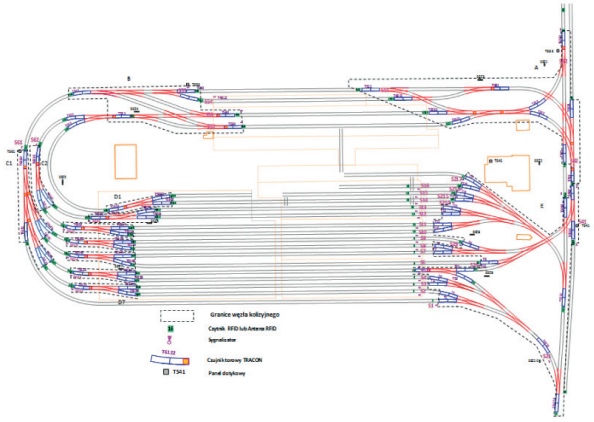

Fig. 8. Elements of the operating system on layout [own study]

3.2. Local operating panels

In manual control of nodes (Level 3), touch panels are used to carry out the following functions:

- selecting a route by selecting the target track and it locks,
- control individual turnouts for unlocked and unoccupied track sections – shunting movements,
- a simplified visualization of the state of the depot (switches, signals, busy sections of track).

The panels are located at the hubs in the depot with a minimum of 4 units (2 entries and a minimum of 2 depot) and a panel TSR. It is possible to realize routes concurrently, as well as to control the Level 1 and 2.

Travel for vehicles equipped with RFID tags using local control panels are covered by the same high level of security, which in automatic mode. Changes make by control panel it requires user authentication.

Due to the ongoing functions of the panels are equipped with tactile graphic displays, and meet the minimum requirements:

- Large temperature range (min. -30 ° C-60 ° C).
- Resistance to rain and dust (IP65).
- High brightness and contrast of the screen.

On the local control panel is running a dedicated application visualization allows for the implementation of the required functions completely independently of the SZZ. The panel is plugged into a network of industrial and communicate directly with the controller SSR.

The application running on the panels by simplifying functional in relation to the master system, have high reliability. Each panel have a dedicated application view allows user to control only the local node-sectoral. The panel allows for the implementation journey by providing:

- The choice of initial track (if more than one initial track);
- Selecting the end track node;
- Retrograde motion.

The panel also allows you to shift the specific crossover (when it is selected) and set alarm - admission. This function is also covered by all the rules of safety - ie. Changeover switch and setting permission to enter the indicator is possible only after the fulfillment of the rules of safety.

In addition to safety, the panel is equipped with a simple access control system. The panel allows to control the node after applying the proximity card.

Control panel for local control (choice of initial track)

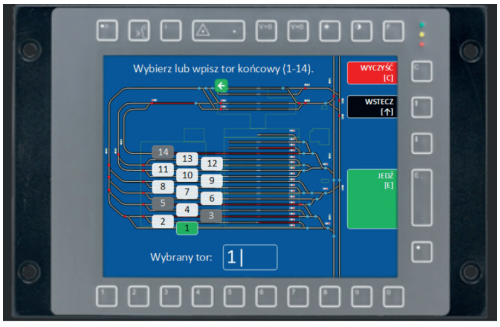

Fig. 9. Local operating panel [own study]

3.3. Interface GUI

The system is equipped with a Graphical User Interface, which allows you to perform all the operations related to both the operation of the system from the system operator and system administration (in accordance with their permission) - Figure 9 and 10.

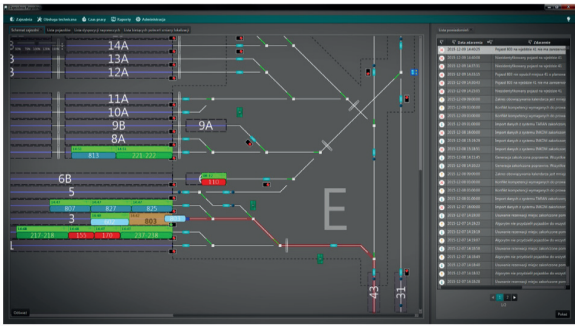

Fig. 10. Customer GUI 1z 2 [own study]

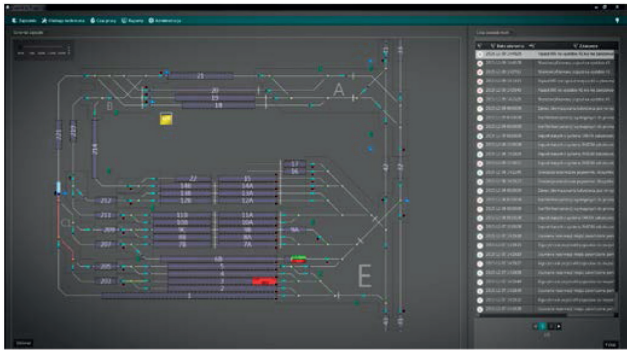

Fig. 11. Customer GUI 2 z 2 [own study]

3.4. Base tasks of the system

The controller of Traffic Control System establishes the desired route on the basis of a request from the generated respectively (depending on the automation) from SZZ, TSR panel or panel for local control.

In automatic mode, a request to establish a route generated by the depot management system based on information about the intended destination for the vehicle or on the basis of instructions entered manually by the dispatcher into the system.

As input parameters, the desired route controller receives data on SSR. The beginning and end of the route. SSR controller then checks whether the route can be set by the driver switches on the basis of:

- the current state / status switches,
- Busy individual track sections (determining the ability to stop safely after switch, and the ability to travel)
- possible collisions routes of entry and exit,
- it is safe to close the gate.

If the route can be adjusted controller SSR switches and blocks the crossovers in the relevant positions. Then colliding with the route passing traffic directions given signal "stop" to keep collision-free passing, and the vehicle receives the signal "go".

In the absence of the possibility of establishing a route, the controller rejects the request SSR Management System depot, Panel TSR or Local Panel.

Addition to the implementation of safety functions and control controller SSR provides to SZZ all information needed to visualize the state of the object and reporting, such as the state of switches, lights and heating.

Traffic Control System allows the concurrent realization of routes of journeys, if these routes meet all safety features (no collision). Transport journey can be any combination of settings switches and signaling fulfilling these functions.

This flexibility allows the realization of SZZ system, or by means of local control panels, efficient traffic tram depot management while maintaining a high level of security.

In addition, it is also controlled the security of gate closing in the depot - using occupancy sensors - for rail vehicles, and presence detectors - to detect people and other equipment.

In the case of closing the gate is guaranteed inflammation of the right light "stop" on the entrance. The gate can be controlled locally using the control panel or buttons, in complete safety carried out by the controllers SSR.

Communication SZZ-SSR is provided be dedicated proven software communication with the drivers in the form of OPC server.

During the design and implementation of SSR contractor ensured all the required procedures, design and testing for system certification to the standard SIL-3.

Configuration node collision

SSR controller allows the reservation of routes within individual nodes in collision.

Levels of safety system SSR

Level	Description	Comments
SIL-3	The system fully operational	Resistant to a single failure. (1)
SIL-2	No marking composition of the RFID-I	Resistant to a single failure. (2)
SIL-1	Hand - remotely longer power failure devices SSR failure of multiple	(3)

1. The system is based on a redundant fiber-optic network, and two central controllers. For fiber-optic network connected systems are inputs and outputs and the local controllers. Any single failure does not limit the functionality of SSR.
2. A larger number of failures is also not causing loss of functionality of the system, but the number of functions performed automatically will be limited. The tram is not detected by the RFID readers - not marked is not positioned at checkpoints certainly required by the SIL-3. Unmarked composition requires information by the dispatcher at the entrance to the depot allowing SZZ determine the parking space.
3. Retraction operation and fault conditions require interference Dispatcher, or tram drivers from desktops installed at selected signals.

4. Conclusion

As part of the requirements specified by the Customer, was deliver Tram Depot Operating System in scope of:

- equipping of track infrastructure and equipping a vehicle in the equipment necessary to implement the automatic functions of the system;
- it was provided the requirement of safety and class SIL-3 in the field of automation control ensuring safe movement of vehicles in the area of the depot through the use of appropriate quality control devices as switches;
- Retrofitting a vehicle, it's necessary equipment for vehicle identification;
- It provides information systems carrying out support functions service depot:
- assigning parking spaces including rules defined by users,
- automatic compilation route for vehicles entering the depot
- automatic compilation of trip routes for vehicles entering tasks of transport as scheduled tasks for the next day;
- collecting and processing data from devices in the trackway and on the vehicle;
- reporting and visualization of the state of infrastructure;
- implementation and execution of orders service and repair;