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Client–server architecture for registration and accounting of railway automation and telemechanics devices

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Abstract:

This article describes the relationship between the maintenance and control schemes of devices in the railway transport automation and telemechanics system. Unified workflows, provenance capture, and analytics-ready data support decisions from engineering and construction to acceptance, service, upgrade, and including termination. The platform follows a client–server model with strict roles and systematic validation. A relational center maintains device passports, installation coordinates, status changes, scheduled swaps, decommissions, and repair logs. QR/RFID identification enables server services indexing, quick search, dashboards, and recurring reports. Using them will result in faster device startup, higher data quality, and transparent results across repair and technology departments. Standard interfaces support integration with adjacent enterprise systems for end-to-end safety, reliability, and efficiency. Operational tools include QR-code and RFID tag – based identification, configurable templates for remote inventories, and automated reporting to support planning and execution at repair and technological sections. Services cover user information, database integrity and recovery, and centralized configuration. Application window formalizes a three-level service model that connects machine interfaces and field mechanics, operators, and administrators. Expected outcomes are accelerated commissioning, improved data quality, and tighter safety assurance via real-time status visibility and auditable document flow.

Keywords:

Railway automation and telemechanics, signaling, centralization, and blocking, QR/RFID identification, server, repair and technological section


1. Introduction

The development and operation of railway networks rely on sophisticated signaling, centralization, and blocking (SCB) technology, whose correct registration and lifecycle management are essential to their proper operation. Currently, separate, paper-based records are frequently used to maintain device passports, installation data, status information, and maintenance records. This leads to issues like duplication, sluggish inventory verification, inconsistent device histories, and reporting. A client-server architecture for railroad automation and telemechanics device tracking and registration is suggested in this article. It accomplishes this by using a relational database to record all asset-related data, including the installation topology, coordinates, history of status changes, maintenance/replacement logs, and a single identifier for each device. In order to lower the possibility of human error during the identification process, the system combines RFID and QR code scanning. The creation of a data model for device passports and event histories, the creation of a device identification mechanism, and the creation of a reporting/search mechanism are the three primary contributions of this solution. The design is set up to preserve distinct procedures for database storage, server validation, and field data collection. When updating device attributes and status changes, this design preserves consistency. Inventory checks are made easier and a clear installation history is provided by a suitable location model that identifies devices by line, station, section, cabinet, and slot. Additionally, common reporting and data sharing interfaces facilitate connection with adjacent enterprise systems.

Against this background, the current railway automation and telemechanics systems have broader functionality. The signaling equipment is controlled and the information is transmitted for safe movement of the trains. The information is received and transmitted in a perpetual flow and the process is more complex for bigger networks. Fault identification and repair require more profound diagnostics. Commissioning suggests longer verification and validation cycles in the process of confirming safe and reliable service [1-4].

Sustainable benefits rely on highly structured, cross-functional work across the chain of automation and telemechanics — design, repair and technological section (RTS) control measurement point (CMP) maintenance, laboratory testing, and dispatch — such that complex faults are rapidly diagnosed and corrected within safety-case procedures. Keeping the teams in constant exchange and discipline allows for timely, authoritative decisions in day-to-day operations. In railway automation implementation, the platform should display clear indicators and dashboards, interface to control systems for real-time access to live states via standardized industrial interfaces, and impose a single device identifier for complete traceability. Following sections lay down architecture, interfaces with interlocking, track circuits and remote terminal units, and the device records and field topology data model connecting them. Baseline measures and acceptance testing define metrics for throughput, defect leakage, and rollout by evidenced facts. The system provides for a reproducible configuration, continuous operation in corridors with different traffic categories, and an audit that reconciles events occurring at facilities with reliable, versioned data. Phased governance clarifies responsibilities

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across the signaling and telemechanics domains and facilitates periodic review for incremental improvement [5,6].

2. Research methodology

The UTA control unit receives power from the locomotive's battery through the closing contacts of the RU16 relay. The power supply voltage is supplied to the external connector XR1 of the control unit to the contacts AO (-Shift) and VO (+75V).

Modification and regulation of database procedures. Error correction for remote data entry in addition to the ability to enter new information remotely in a similar format. If you did

not complete this previously, you must determine the automatic method upon opening the standard taskbar. Figure 1 shows the application window hierarchy and the main user workflow.

The diagram outlines the application's window hierarchy. Basic and Login forms lead to functional panels. The New data panel adds workshops, sections, and devices. Data view enables editing properties, editing sections, and viewing device tables. A QR-code (Quick Response) and RFID (Radio Frequency Identification) tag panel supports printing, scanning, and previewing. Lanes separate program, login, and window types [7-9].

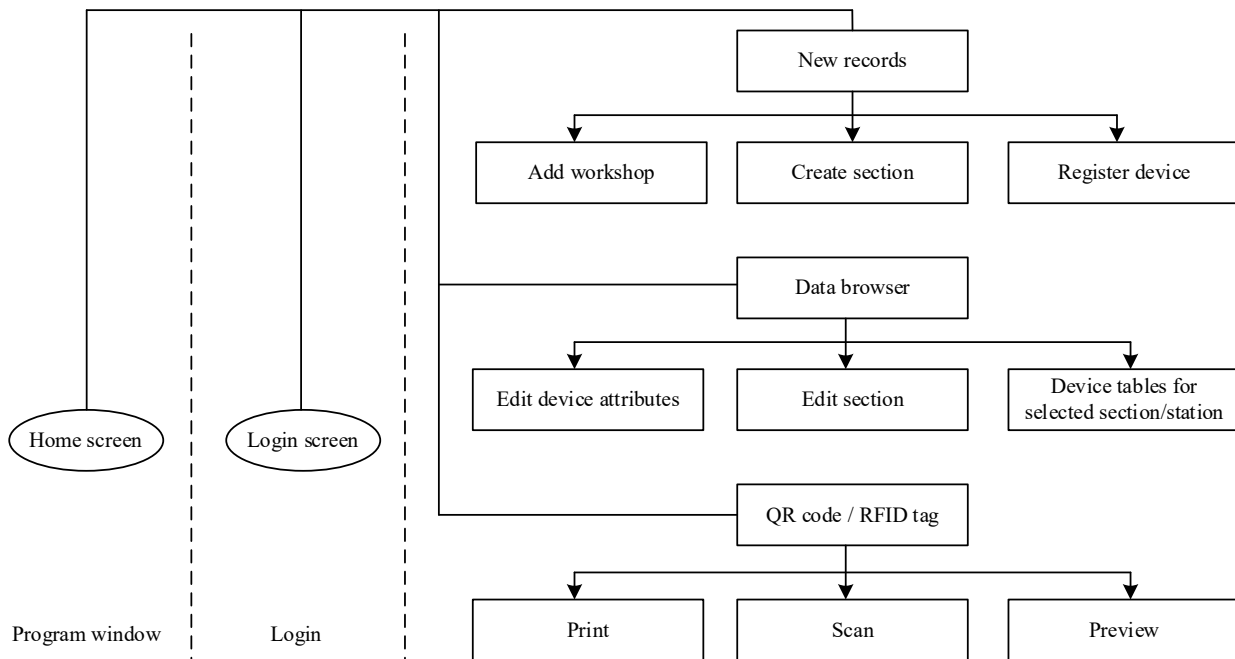


Fig. 1. Application window hierarchy and flow

An automated control and accounting system for railway automation and telemechanics devices (ACA-SRAT) constitutes a mechanism for overseeing the operations of the RTS and is situated on a computer integrated within the RTS framework. Necessary resources for formulating work plans throughout the RTS division, encompassing the RTS distance and specific responsibilities, are aggregated, and a database that is continuously updated records the movements of all devices, including both identified and unidentified units. Work

orders utilize an identifier to reference each device, while QR/RFID scans document the installation process, status updates, and geographic location. The module facilitates the validation of replacements, coordinates maintenance schedules, and produces analytical reports concerning failures and the allocation of resources. The design and framework for device registration and management within the railway automation and telemechanics system are illustrated in figure 2.

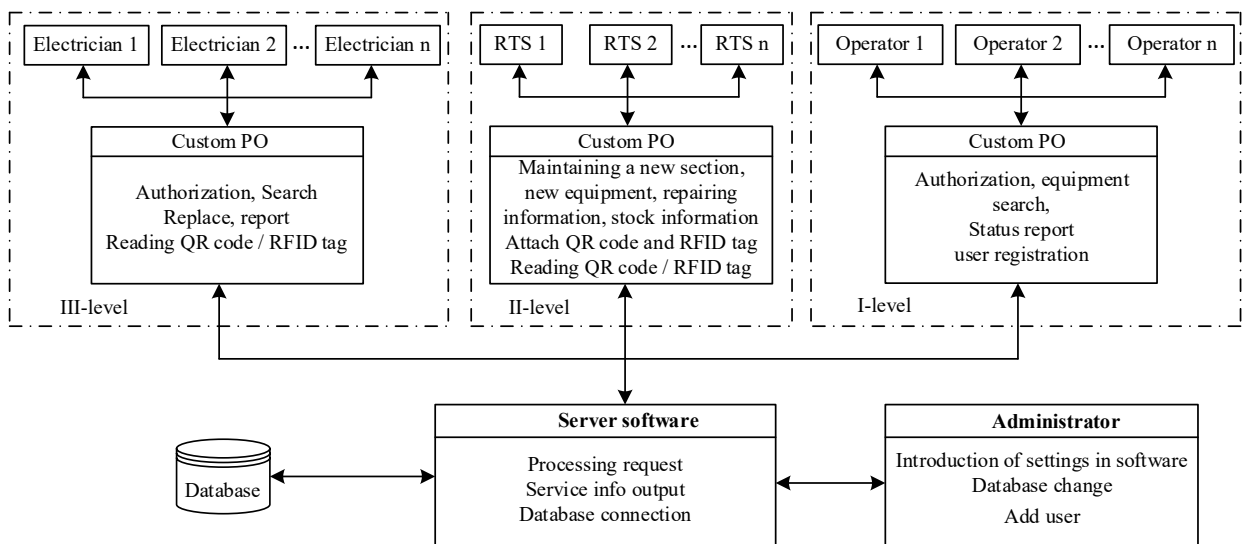


Fig. 2. Model architecture for a digital inventory and control system in railway signaling

The ACA-SRAT operates from a server in the signaling communication distance network. You can apply this role to an existing workstation or a distinct machine. Accommodate storage growth — device onboarding, jobs creation, and reporting continue the database footprint [10-12].

Specifically, the following tasks are the responsibility of the system administrator:

- reflection within the organization’s present structure system;
- registering users;
- system check for alerts and error messages;
- making changes to database tables.

The main operating window of the program appears after the user’s server is successfully connected. It is a simplified toolbar and top menu single document window. All the general functions of the automatic system are shown ergonomically by the user in this dialog box, i.e.:

- entry of device data;
- receipts for devices;
- device write-offs;
- return of the devices after repair;
- device replacement schedule;
- device inventory;
- unpacking the equipment.

Electronic document flow in railway automation and telemechanics implies the replacement of paper copies by a single structured database. The device passports and operating records are entered by controlled forms. Then it fully covers all the processes step by step — commissioning, routine maintenance, replacement, and decommissioning — while maintaining links to line, station, cabinet, and slot topology [9].

Rapid lookup is essential for SCB operations. The document subsystem thus presents the indexed search across key attributes. The primary keys are the installation address (line–station–section–cabinet–slot) and the device brand/model. The secondary filters — status, last service date, firmware revision, responsible unit, and timestamp — minimize query latency while handling incidents and work planning. Audit trails, access control by role, and referential integrity provide traceability of edits and synchronization with field assets. The methodology provides a good source of

device data for signaling, centralization, and blocking processes.

The account and control system for SCB devices is based on a clear architecture, defined workflow for operations, and controlled modification of data. The implementation of an electronic document flow as a common, normalized repository (e.g., ACA-SRAT) combines device passports and transactions, removes redundant entries, provides referential integrity and decommissioning in the line–station–section–cabinet–slot configuration. Devices embedded in this flow benefit from better coordination, traceable changes, and standardized reporting.

A QR-code and RFID tag identification layer integrated in the subsystem enables automatic device identification at the field and the repair facilities. All writes create audited, versioned records under role-based access control. Indexed searching across brand/model and last service date facilitates quick lookup for maintenance scheduling and incident response [2,6,7].

The parameter management procedure in SCB devices is updated continuously, gathering all required data directly from the device. This method, which works with practically all nodes and blocks, enables prompt failure detection and the adoption of a “recovery-oriented” maintenance mode. The service’s top objective is the consistent delivery and deployment of incredibly durable and dependable infrastructure components that are completely compatible with automatic blocking, centralized motion control, and electrical centralization based on microprocessors. When combined with electronic document management (ACA-SRAT, for instance), this method keeps device passports and transactions in one location, regularly logs modifications, and facilitates planning and quick recovery through standard reporting.

At the same time, railways should adopt new domestic and overseas microprocessor-based interlocking, automatic block, and dispatching systems, paying close attention to compatibility, phased adaptability, and reduced service disruption. Ongoing monitoring, controlled data updating, and traceable maintenance records should support such flexibility.

A step towards modern service technology is inevitable for telemechanics and railway automation. The goal is the minimization of human error in providing smooth running and safety of rail traffic by automating maintenance work as far as

possible. Asset condition and task performance should be centrally controlled due to the scarce availability of highly qualified staff and the necessity for standardized quality.

Professional communicators and signalmen play a great role in boosting productivity and safety at the point of train operations. Efficient and harmonious teamwork in this highly complicated production-technical system allows for swift overcoming of operating challenges and reduction in interruptions.

The system catalogs each device, tracks movement between locations, and assesses operational status. It maintains document workflows, implements role-based responsibilities, and facilitates quick access for deployment, incident management, and scheduled maintenance. It automates the registration, inventory management, and status oversight of SRAT assets, substituting traditional paper workflows with regulated, data-centric procedures.

ACA-SRAT optimizes repair and replacement activity quality and productivity, enables evidence-based manager and subject-matter-expert decision-making in the areas of the field of signaling and communications and the automation–telematics laboratories, and strengthens planning, optimization, and execution control. Through the combination of device passports and work transactions in a single

normalized repository, it reduces redundancy, enforces integrity, and provides for contemporaneous analytical reporting.

A specialized document-flow server provides as the foundation for user activities. By utilizing this service, users are able to scan QR codes and RFID tags to identify device identifiers, produce inventory and workload reports, and perform indexed searches within the equipment database. The server facilitates all document operations, validations, and audit trails; consequently, user activities cannot proceed unless the service is operational and authentication has been achieved.

For small deployments, the document-flow server and database engine can even coexist on the same host. This reduces hardware footprint and intra-network traffic while maintaining transactional integrity and access control and decreasing administration.

Locating each device by database requests is easy because for each device a set of definitive details is assigned upon registration.

The block diagram of the automated registration and signaling system control system’s block diagram is shown in figure 3.

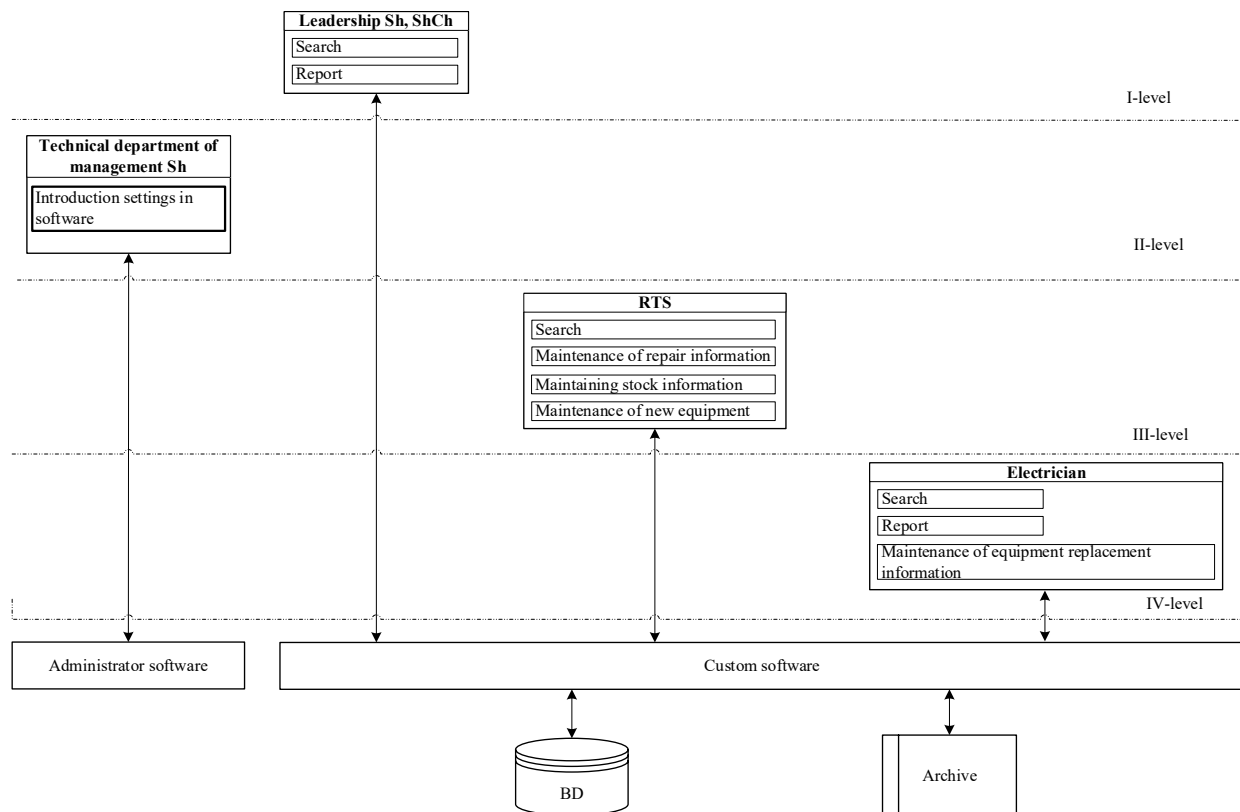


Fig. 3. Automated architecture of the device registration process in the railway automation and telematics system

The server includes a configurable database connectivity module. An administrator selects any reachable host as the data source and sets core parameters: IP or port, database name, and credentials with scoped read/write/update rights. It creates schemas and tables, applies flexibilities, and seeds reference catalogs and default roles. This removes the need for third-party tools or advanced SQL (structured query language) skills and lets the workflow system start immediately after installation [12-15].

For railway automation and telematics, this execution main underpins a centralized flow of electronic documents throughout the communications and signaling distance and partner units. It also systematizes technical procedures documentation in a standardized manner, automates registration and control of SCB devices’ statuses, traces device movements end-to-end, and stores all interventions in the form of audit traces. The end effect is

improved throughput, reliable tracking, and synchronized control across the automatic control subsystem.

3. Conclusion

The research reveals an improved client-server architecture for electronic document management and device management, improves the procedures for commissioning signaling, centralization and blocking devices, and fully ensures device control in the railway automation and telemechanics system. Processes such as registering devices, monitoring their operation, creating a replacement schedule, planning repair work, entering device data into the database and issuing them are provided by the automated device control system. The use of QR code and RFID tag identification increases accuracy in RTS areas and speeds up inventory processes, while the consolidation of the server infrastructure reduces hardware requirements and simplifies maintenance procedures. An expanded real-time view of the status, the use of standardized templates, and a centralized management system have been developed to reduce mechanical personnel errors, accelerate commissioning, and encourage continuous improvement of service technology.

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| | |
|---|----|
| J. Sodikov, Dr. Konsta Sirvio, S. Nirzazoda <i>A GIS framework for road asset monitoring in mountainous regions: a Tajikistan case</i> | 5 |
| S. Razzakov, A. Martazaev, I. Egamberdiev <i>Economic efficiency of glass fiber reinforced concrete</i> | 14 |
| M. Shukurova, Kh. Ruziev <i>Bayesian shrinkage estimation for extreme values in 3D satellite-based geospatial modeling of oil and gas systems</i> | 17 |
| M. Mardanov <i>Problems and solutions of organizing pedagogical practice remotely for students of technological education</i> | 23 |
| I. Sadikov, E. Joldasbaev <i>Predicting the rheological response of Uzbekistan's polymer-modified binders: a comparative analysis of conventional empirical tests and the complex shear modulus</i> | 26 |
| A. Ernazarov, B. Umarov, J. Tojiev <i>Application of artificial intelligence in traffic management in the city of Jizzakh (Uzbekistan)</i> | 31 |
| M. Ravshanov <i>Prospects for implementing public-private partnership in managing the resource capacity of the road – transport complex</i> | 35 |
| U. Safarov, N. Julenev <i>Diagnostics of locomotive power electrical circuits using the USTA device during rheostatic tests (Based on 2TE10M / UzTE16M)</i> | 40 |
| D. Kosimova, Kh. Ruziev, J. Juraev <i>Methodology for developing optimal-system models to improve investment efficiency in regions: evidence from the Kashkadarya region</i> | 44 |
| O. Boltaev, F. Akhmedova, I. Ismoilov, Kh. Ostanaev <i>Computer model that allows assessing the electromagnetic effect of traction transformers on adjacent lines and systems</i> | 53 |
| D. Baratov, E. Astanaliev <i>Client–server architecture for registration and accounting of railway automation and telemechanics devices</i> | 57 |
| N. Sulaymonov <i>Organizational technological mechanisms for the development of outsourcing services in the organization of cargo transportation in transport and logistics enterprises</i> | 62 |