NPS // SIGNALING DIVISION

PRODUCTS AND SOLUTIONS
SIGNALING DIVISION
of GC NPS

CONTENTS

TRAIN CONTROL AND SIGNALING

in the digital era

The Signaling Division of the Group of Companies Natsproyektstroy is a global system integrator capable to provide a full-service customer support of the supplied signaling and communication systems and equipment throughout the entire lifecycle.

The Division comprises the following Russian companies, having at their disposal the full range of solutions for the railway transport: ELTEZA, 1520 Signal, Stalenergo, Dialog-Trans, CyberTech-Signal, ATIS, RoSAT and TransZhelDorProekt. These companies design, produce, supply and implement innovative systems of train control for mainline, industrial and mass transit rail transport.

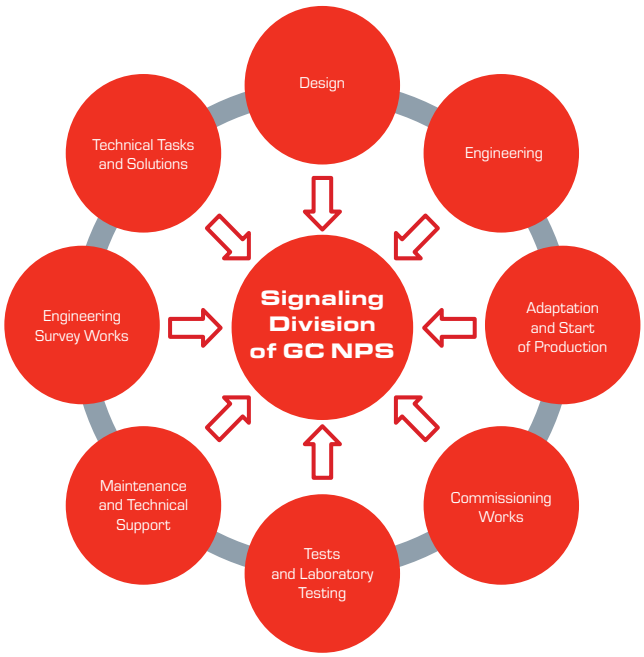
Our companies have implemented the **breakthrough radio-based train control system with moving blocks** (ETCS Level 3 functionality) on the railways with a total length of 2,000 km in Kazakhstan and of 1,111 km in Mongolia within the framework of the Trans-Mongolian Mainline upgrade project.

Lately, the Signaling Division of GC NPS keeps implementing **large-scale projects** involving installation of signaling and communication systems on the Moscow Central Circle (MCC), Moscow Central Diameters (MCD), Trans-Siberian Railway and Baikal-Amur Mainline (Eastern polygon of JSC RZD), as well as on the Moscow and Tashkent metro lines and at the depots. Our automated system for tram traffic integrated control is used on the Russian capital's tram lines.

The Division's products are highly reliable in a wide variety of climatic conditions—from Yakutia with its severe winters to hot deserts with their sandstorms in the Central Asia.

In order to reach strategic objectives and consolidate research and engineering experience, **a unique Unified Engineering Center has been created.** It includes more than 500 world-class developers. This signaling technological cluster with accumulated engineering resources has become the key integrator in the global digitalization process of the Russian and international railways.

Services provided throughout the entire lifecycle



SOLUTIONS FOR ENTIRE LIFE CYCLE

of the signaling equipment for mainlines, mass transit and industrial railway transport

THE SIGNALING DIVISION OF GC NPS

Complex integration during the whole life cycle of signaling equipment and systems

- System Design. Tests. Certification
- Production. Contract Assembly. Localization
- Equipment Supply
- Maintenance
- Recycling
- Construction and Installation Works in the Signaling Field. Overhaul. Modernization

Expertise of the Signaling Division of GC NPS allow providing its customers with a full range of services in the field of signaling and communication: project management, engineering, design, production, training and maintenance—up to recycling of obsolete equipment. Moreover, the Signaling Division of GC NPS implements turnkey projects with full-service customer support throughout the whole life cycle of signaling and communication systems and equipment.

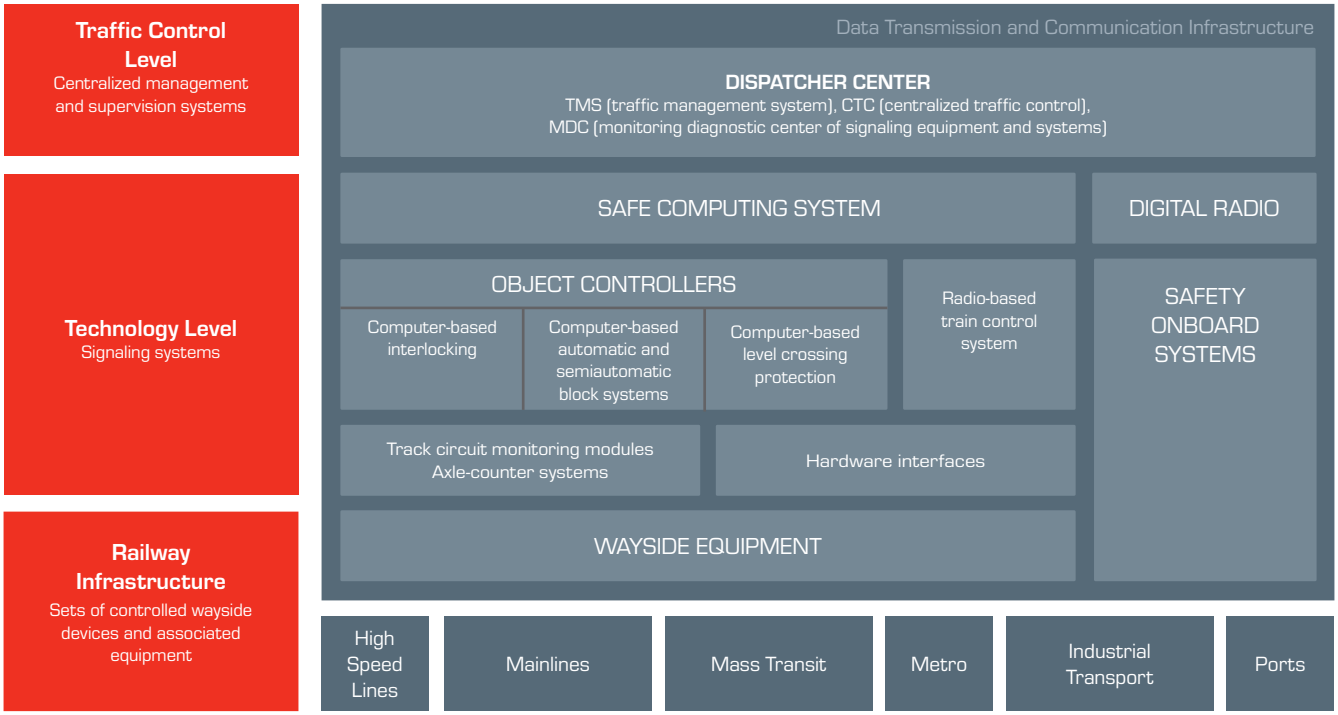
UNIQUE EXPERIENCE OF PROJECT MANAGEMENT

The Signaling Division of GC NPS is one of the few integrators in the world capable of full-service project management in the field of signaling and communication in accordance with national as well as international standards. It is particularly important in situations when the projects are financed from the budget of international structures and investment funds. The Division specialists provide project management at every stage—from organizational planning and work execution control up to interaction with subcontractors, risk management and control of financial metrics.

LEADER POSITION IN NEW TECHNOLOGIES

Engineering centers of the Signaling Division of GC NPS have been the leaders of the market for many years by successfully developing and implementing new technologies in the signaling field. The Division has a unique experience of technology transfer from

Integrated system solutions for all customers



international partners and production localization of signaling equipment and systems.

The companies of the Division have commissioned the Russia's first computer-based interlocking system at the Kalashnikovo station in 1999 and were the first in the world to launch the radio-based traffic control system with moving blocks on mainlines.

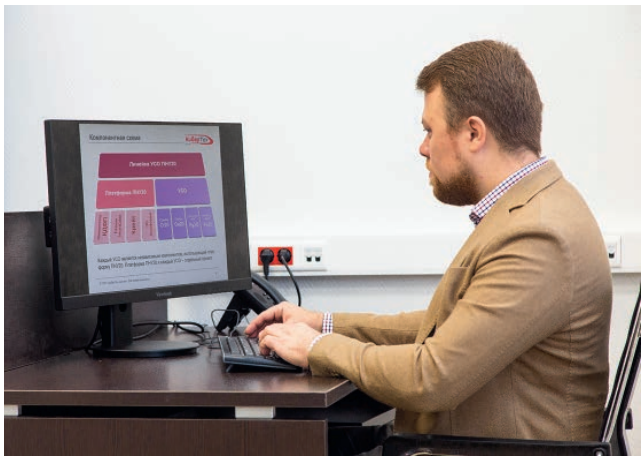
The variety of innovative solutions of the Division covers the whole complex system of signaling means for mainlines, mass transit and industrial railway transport. The Division has the industry-best specialists with unique expertise, familiar with the signaling specyifics and capable of solving any problems at the international level.

MODERN PRODUCTION FACILITIES

The Signaling Division of GC NPS has a coordinated team of engineers, a test center and powerful production facilities that comprise 10 industrial enterprises and manufacturing sites. The range of products contains 8,000 types of components, devices, signaling and communication systems that are used to build high- technology solutions for every type of rail transport.

SERVICE

The Signaling Division of GC NPS was the first in Russia to organize a system of 24/7 maintenance support of computer-based signaling equipment and to provide warranty and post-warranty maintenance at all levels. Our customers can count on reliable supply of spare parts and components during the whole life cycle, modernization of the equipment and prolongation of its life cycle, major maintenance and recycling of obsolete signaling equipment.



GLOBAL SCALE LEADERSHIP —

projects implementation of any complexity level

The Signaling Division of GC NPS has successfully implemented digital systems at more than 1,100 sites in Russia and abroad. The train control systems developed by the Division have allowed creating the railway Eurasian corridors with East-West and North-South directions that are used for heavy haul trains and express container trains.

RUSSIA

In Russia, the Division companies have been operating since the beginning of the previous century. For many decades they have supplied hundreds of thousands of units of signaling and communication equipment that keeps operating on all the railways of the "1520 area" and beyond. In 1999, the Signaling Division of GC NPS launched the first ever computer-based interlocking on the JSC RZD network that was the first step towards the digitalization of the railway signaling. Currently, more than 480 stations (approximately 13,000 points and more than 1,200 km covered by the automatic line block) in Russia are equipped with our CBI systems.

The flagship projects of the Signaling Division of GC NPS are the Trans-Siberian and Baikal-Amur mainlines, the Moscow Central Circle and the Moscow Central Diameters, where the installed signaling systems, designed and produced by our companies, provide uninterrupted and safe train traffic with minimal intervals.

CBI systems and other signaling equipment designed and produced by our Division are in operation on the Moscow—St. Petersburg mainline, where high-speed Sapsan trains run. The application of the Division

The Division's signaling systems are used on the Trans-Siberian Railway section, which includes the brand-new Kerak tunnel

The Moscow Central Circle was equipped with computer-based interlocking systems by the Signaling Division of GC NPS

systems is also planned for the new high speed lines designed in Russia.

The Signaling Division of GC NPS has implemented the first CBI systems and digital traffic control systems in the Moscow Metro. On the Circle Line of Moscow Metro, the Division's digital solutions have shown a record-high capacity—45 pairs of trains per hour at an average train-to-train interval of 80 sec.

In 2023 the Division started deployment of automated system for tram traffic integrated control in Moscow, which will allow increasing the point passing speed and tramway capacity.

CIS COUNTRIES

The Division has the leading position in the field of signaling systems on the majority of CIS railways. The technical solution for the modernization of signaling equipment on Baku—Böyük Kəsik mainline developed by the specialists of the Signaling Division of GC NPS allowed winning the competition against some leading international companies.

The Division has successfully implemented CBI and other signaling equipment on several lines of Uzbekistan railways, including the sections with higher speed train traffic. The Division's digital automation systems operate in Tashkent Metro.

The breakthrough radio-based train control system with moving blocks (RBTC) that implements ETCS Level 3 functions was installed in Kazakhstan in 2011 on lines with a total length of 2,000 km. CBI, RBTC and CTC systems provide stable operation of the Eurasian corridor in Kazakhstan.

CENTRAL AND EASTERN EUROPE, MONGOLIA

Since 2000, the Division has been taking part in CBI projects implementation on strategically important sections and transportation hubs in Latvia and Lithuania. Technical solutions developed by our specialists have successfully withstood competition against the offers made by the leading European companies. In 2007, the Signaling Division of GC NPS has developed the first

The Circle line of Tashkent Metro is controlled by the Signaling Division of GC NPS's digital automation system

In may 2025, the Signaling Division of GC NPS implemented a CBI system at the Müsüslü station (Azerbaijan)

projects beyond the 1520 gauge area by equipping three stations in Slovakia and light metro line in Istanbul (Turkey) with CBI systems. In 2016, the Division entered the Serbian market and successfully modernized the signaling equipment on the Resnik—Valevo section that is 77 km long and is a part of the Trans-European transport corridor X.

On the Mongolian market, in 2019 the Division has completed a large-scale project for the complex modernization of the Trans-Mongolian mainline that is 1,111 km long, with the implementation of radio-block system with moving blocks and CTC over the existing relay interlocking systems.

PARTNERSHIP
in Russia and abroad

The Signaling Division of GC NPS moves beyond its own developments and strives to use state-of-the-art technologies of the leading Russian and international technology companies and research centers in the technical solutions offered to its customers on the basis of mutually beneficial partnership.

SUCCESSFUL PARTNERSHIP WITH RAILROADS

The Signaling Division of GC NPS closely cooperates with its main customer—Russian Railways (JSC RZD)—for many years. It was thanks to this partnership that the first Russian computer-based interlocking system was implemented in 1999. Further on, the CBI system using foreign components and software developed by the Division's engineers and then its newer version made entirely of Russian components became the most widespread in the "1520 area" (more than 700 stations).

CBI-E and other systems based on it are deployed on the foreign railways, while CBI-EL is intended for Russian market, but can be exported as well. Experts of the Division are actively involved in the best practices courses and other events arranged by JSC RZD. One more Russian partner of the Division is Yakutian Railway, which network is being equipped with our modern computer-based signaling systems.

The Signaling Division of GC NPS is active at developing a strategic cooperation with the railroads of Azerbaijan, Kazakhstan, Serbia, Uzbekistan, as well as Ulaanbaatar Railway and Mongolian Railway (MTZ) using for meetings, negotiations and experience sharing events like St. Petersburg International Economic Forum (SPIEF), Eastern Economic Forum (EEF), INNOPROM international industrial exhibition and other forums both in Russia and abroad.

In 2011, the Division implemented the first-ever radio-based train control system with moving blocks (RBTC) that complies with ETCS Level 3. Currently, RBTC successfully operates in Kazakhstan and Mongolia on railway lines with a total length more than 3,000 km. Large-scale projects were also implemented in Azerbaijan and Uzbekistan.

To develop projects abroad Russia, the companies of the Signaling Division of GC NPS have signed partnership and cooperation agreements with multiple international companies.

COOPERATION WITH RUSSIAN TECHNOLOGICAL LEADERS AND RESEARCH CENTERS

Thanks to an important memorandum signed with MCST JSC in 2018 at the TRANSZHAT conference, JSC ELTEZA gained access to the advanced Russian

At the Eastern Economic Forum in September 2023, GC NPS and Yakutian Railway JSC have signed a memorandum of cooperation in the field of digital safety and control systems for critical infrastructure facilities

GC NPS is signing an agreement with Togliattiazot (TOAZ) PJSC on the construction of railway infrastructure of a new ammonia transshipment complex in the Seaport of Taman. St. Petersburg International Economic Forum, June 2023

Meeting with the Kazakh partners in the GC NPS booth at the INNOPROM.KAZAKHSTAN industrial exhibition. Astana, September 2023

technologies on the basis of the Elbrus microprocessor units and to the secure computing technologies. ELTEZA successfully implements computing devices with the Elbrus microprocessor units into the CBI-EL and other signaling systems.

The Signaling Division of GC NPS actively cooperates with the Russian universities. The Division has a longstanding cooperation with the Russian University of Transport (MIIT) that has a training room equipped with the CBI-E system and where its students as well as RZD operational staff are trained.

At the international PRO//Motion.1520 exhibition on August 28, 2019, a new agreement with the Russian University of Transport was signed that provides for a long-term cooperation in the field of computer-based control systems, staff training and accumulation of the advanced knowledge and experience necessary for solving modernization and development issues on railways. Within the framework of the exhibition, another cooperation agreement with Transtelecom, a Kazakh company, was also signed.

During the international PRO//Motion.1520 transport forum, a memorandum of cooperation with Mosgiprotrans was signed. The memorandum implies cooperation during planning, surveying, research and development works under the projects for the construction of transport infrastructure facilities in

ELTEZA JSC, part of the Signaling Division of GC NPS, wins a prize for the best innovative project from V. A. Gapanovich, President of the Union of Industries of Railway Equipment. PRO//Motion.Expo International railway fair, 2023

Russia and abroad. The following years have brought new partnership agreements with Russian and foreign companies.

DESIGN FOR THE MAINLINES,
mass transit and industrial railway transport

The Signaling Division of GC NPS benefits from the long-term experience in the design of signaling systems using the modern computer-based as well as traditional relay element base. These works are performed by highly qualified specialists of the Division using the advanced computer-aided design (CAD) systems.

LARGE-SCALE PROJECTS ON THE "1520 AREA" MARKET

Our specialists designed the signaling systems within the framework of the largest projects in Russia and other countries of the 1520 gauge area on the mainline railways, including:

- the Moscow Central Circle;
- the Moscow Central Diameters;

- reconstruction and development of the Eastern Polygon of JSC RZD;
- the Moscow — Kazan High-Speed Railway;
- the railway line bypassing Ukraine;
- modernization of the railway infrastructure on Sakhalin;
- the upgraded and new lines in Kazakhstan,
- Mongolia, Uzbekistan and other countries.

The Signaling Division of GC NPS provides a full range of work for design of the CBI equipment — from development of basic design concept, design and detailed documentation, to undergoing the expert review and getting approval for the design estimate documentation in the state and internal expertise authorities, as well as in construction and installation supervision authorities.

SIGNALING SYSTEMS FOR THE METRO

The Signaling Division of GC NPS has an extensive experience in design and development of train traffic control and safety systems for the metro using the modern components, in particular, using the CBI and hybrid systems, digital track circuits and communication equipment.

INTEGRATED APPROACH FOR INDUSTRIAL TRANSPORT

The big advantage of the Division is an integrated approach to the design of the CBI equipment on industrial railways:

- participation in the development of major draft decisions;
- development of design and detailed documentation for the reconstruction of signaling systems;
- undergoing the expert review and getting approval for the design estimate documentation in the relevant authorities;
- construction and installation supervision.

INDEPENDENT
Test Center

The Signaling Test Center (Signaling TC) operates at JSC ELTEZA, which is a part of the Signaling Division of GC NPS. The Test Center is accredited by the National Accreditation Authority, the Federal Service for Accreditation (RusAccreditation), for compliance with the requirements of GOST ISO/IEC 17025 "General Requirements for the Competence of Testing and Calibration Laboratories".

In 2015, the Center passed successfully the confirmation procedure both for technical competence and for independence. As a result, it was included in the national part of the Customs Union Register. The Center received the right to test products for compliance with the Technical Regulations of the Customs Union 002/2011 "On the Safety of High-Speed Railway Transport" and 003/2011 "On the Safety of Railway Infrastructure within the approved area of accreditation".

ACCREDITATION OF SIGNALING SYSTEMS AND EQUIPMENT

The accreditation area of the Signaling Test Center of JSC ELTEZA includes a wide range of signaling systems and equipment subject to mandatory compliance confirmation: automated control and monitoring systems, workstations, relays, relay blocks, decoders, sensors, electric point machines, signaling software, as well as a large list of equipment subject to voluntary certification. This includes signals, barriers, track circuit equipment, converters, transformers, power supply units, racks, cabinets, etc.

The Test Center participates in approval of test methods and programs for different stages of the signaling equipment life cycle, reviews and issues conclusions on documents like "Safety Assurance Program" and "Safety Certificate".

Testing of a signal fragment on a vibration-testing machine (vertical vibration)

DEVELOPED MATERIAL AND TECHNICAL FACILITIES

The Test Center owns various state-of-the-art equipment that allows conducting all required tests for functional performance, climatic and mechanical effects, as well as simulating electromagnetic interference.

Testing of a point machine

MODERN PRODUCTION FACILITIES

8,000 product types

The Signaling Division of GC NPS is the largest developer and producer of signaling equipment ranging from wayside equipment to complex computer-based train control and safety systems and digital communication systems in the "1520 area" market. In total, the Division offer includes more than 8,000 products.

All the Division facilities use an efficient quality management system that is certified in compliance with the ISO 9001:2015 international standard and the IRIS railway standard.

Manufacturing facilities of the Division in Moscow, the Urals, St. Petersburg, Volgograd, Armavir and Yelets are parts of JSC ELTEZA, whilst the facility in Belgorod is an affiliate of Stalenergo Ltd. Other companies also have assembly sites and preoperational test centers for running factory tests of signaling systems. Currently, there are more than 5,000 employees working for the Signaling Division of GC NPS.

COMPUTER-BASED SIGNALING AND DIGITAL COMMUNICATION SYSTEMS

Production of high-technology computer-based signaling and digital communication systems is primarily located at the manufacturing facilities in Moscow and Belgorod.

The production facility in Moscow where cabinets are assembled

Track circuit laboratory at the production facility in Moscow

Test laboratory of the Unified Engineering Center

Laboratory testing of an in-sleeper electric point machine

A tool house at the production facility in Moscow

The production facilities of the Division are equipped with technology that makes it possible to assemble and install electric modules in semi-automatic mode with automated soldering. Ready-made products and components are carefully checked by the quality control department.

ELECTRIC POINT MACHINES, SIGNALS AND OTHER WAYSIDE EQUIPMENT

The facility in Armavir specializes in manufacturing electric point machines, automatic barriers, level crossing protection devices and signals for railways and metro. CNC machine tools, modern metal treatment technologies and instant diagnosis methods are widely used by the production facilities of the Division across all the stages of the manufacturing process.

RELAY PRODUCTS

The production facility of the Signaling Division of GC NPS in the Urals (the city of Kamyshlov) is responsible for the manufacture of relay products, which include more than 3,000 different product types. The factory also makes ATP equipment, blocks of an executive group and of an electric interlocking route set, racks, unified relay cabinets, etc.

OTHER EQUIPMENT

The facilities in St. Petersburg, Volgograd and Yelets make electronic ATP equipment, transformers, impedance bonds, track boxes, cable terminals and a range of various tools and accessories.

MAINTENANCE SERVICE

Provision of uninterrupted operation of the systems

SERVICE CENTER NETWORK

The Signaling Division of GC NPS consistently expands the network of service centers in Russia and abroad to provide a high level of maintenance of the supplied systems.

At present, the Division has a main service center in Moscow and nine regional service centers in the Russian Federation: in Yekaterinburg, Irkutsk, Krasnoyarsk, Novosibirsk, Rostov-on-Don, Saratov, Khabarovsk, Chelyabinsk and Chita. The Division service centers are situated in Baku (Azerbaijan), Astana (Kazakhstan), Karshi (Uzbekistan) and Ulaanbaatar (Mongolia).

Service centers of the Signaling Division of 1520 GC

Russia 10

Azerbaijan	Kazakhstan	Mongolia	Uzbekistan
1	1	1	1

The regional service centers allow providing technical support to the operating staff of the railways equipped with our computer-based systems. Specialists of our service centers perform the whole range of work to maintain our computer-based systems and repair them in case of failures, if the railroad employees cannot fix them.

The Signaling Division of GC NPS provides a 3-year warranty for all the supplied equipment. During the warranty period, the Division undertakes to replace all the failed equipment free of charge unless the failures have occurred due to bad operation conditions.

MULTI-LEVEL SUPPORT SYSTEM

The Signaling Division of GC NPS has developed and offers a multi-level support system that takes into consideration the customers' interests, the maintenance capabilities of the company and the required availability level of the computer-based equipment.

When signing a maintenance contract, the customer can choose one of the several levels of technical support:

- level 1— technical support 8/5: on weekdays from 9.00 to 18.00 Moscow time;
- level 2 —technical support 24/7;

- level 3 — technical support 24/7 and routine maintenance;
- level 4 — technical support 24/7, routine maintenance, emergency response and remedial maintenance.

Routine maintenance covers preventive maintenance, analysis of the system operation, recommendations on the equipment operation and training of the customer's operational staff by the Division's experts.

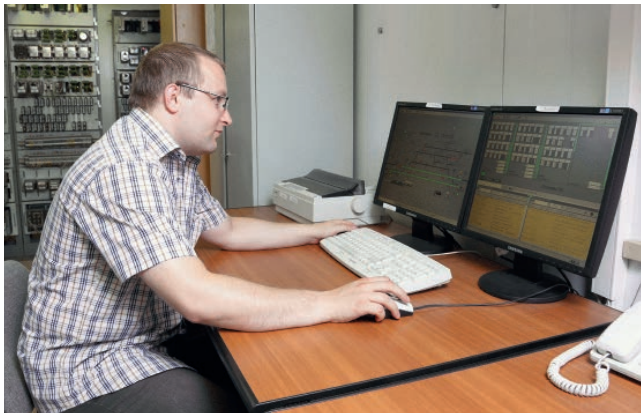
Emergency response and remedial maintenance covers equipment repair, guaranteed site arrival for corrective activities and unscheduled on-site visits to investigate the failures in the system operation.

STAFF TRAINING

The Signaling Division of GC NPS pays great attention to training of the customer's specialists in operation of the supplied systems.

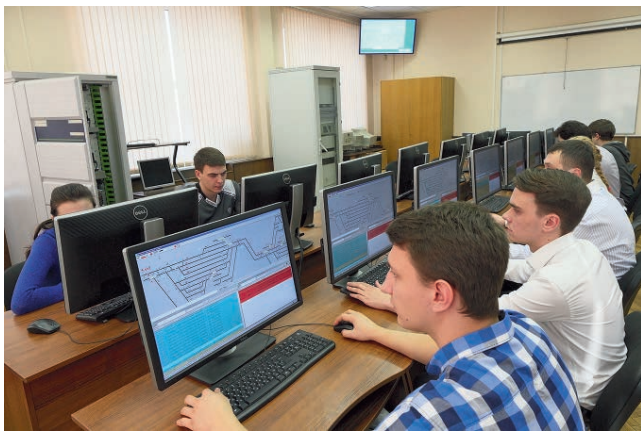
The customer staff training is divided into two stages. At the first stage, the staff is trained during the factory testing of the system in the laboratories of the Signaling Division of GC NPS. At this stage, the customer's operating staff are familiarized with the CBI designed for a specific project. At the second stage, training is conducted at the implementation site during commissioning.

Advanced training courses and occupational retraining courses for the the Russian Railway employees are regularly held at the Russian University of Transport (MIIT), where the Signaling Division of GC NPS has equipped a laboratory with the CBI-E computer-based interlocking system. CBI-E operation training can be conducted at the Irkutsk State University of Railways and Ulan-Ude College of Railway Transport. The CBI training rooms are arranged at a number of railways.



Service engineer checks the operation of a CBI-E system installed on the Moscow Railway

Training of the operating staff in Karshi (Uzbekistan)



The CBI-E computer-based interlocking classes in a training room at MIIT

TRAINING ROOMS

Staff training

The Signaling Division of GC NPS pays great attention to training of the customers' specialists to operate and maintain the supplied systems. Therefore the Division has developed a training system for the CBI-E computer-based interlocking—a hardware/software package that fully replicates automated workplaces of a station duty officer and operating staff, as well as wayside equipment of a simulated station. Such training rooms have also been developed for the CBI-EL system. One of such training rooms operates on the Children's narrowgauge railroad in Saratov.

The software of the training room fully simulates the operation of a station duty officer and the field engineering unit, including the control of train and shunting operation, the input of responsible commands, emergency response, analysis of system logs and diagnostic data. Also, the operation of the CBI central processing unit, object controller system, telecommunication and signaling wayside equipment is simulated. The first CBI-E training room was introduced on the Moscow railway in 2010.

The trainee's automated workplace (main and standby) in the training room of the Moscow Railway

The demonstration and training complex for radio-based traffic control systems

A NETWORK OF TRAINING ROOMS IN THE "1520 AREA"

At present, training rooms operate on Moscow, Far Eastern, Krasnoyarsk, East Siberian, South Ural, Sverdlovsk, West Siberian and Yakutian Railways. Over the years, more than 3,500 specialists (station duty officers and electrical engineers) have upgraded their skills here.

In 2019, the first training room appeared in the capital of Kazakhstan. Training is also carried out in service centers that are open in Baku (Azerbaijan), Tashkent (Uzbekistan) and Ulaanbaatar (Mongolia).

VR SIMULATOR—DEMONSTRATION AND TRAINING COMPLEX

The Signaling Division of GC NPS supported by JSC RZD has developed a VR simulator, a demonstration and training complex for radio-based traffic control systems. The complex uses actual locomotive controls and displays a simulated video of a train movement along actual sections of Russian Railways via a screen and VR headset.

It allows training the staff and students in operation of advanced train control systems and practicing the driver's actions in emergency situations.

CONSTRUCTION
and installation

Offering a whole spectrum of services for the full life-cycle in the signaling and communication field is an important competitive advantage of the Signaling Division of GC NPS. One of the key elements of the life cycle is construction, installation, and commissioning of signaling equipment.

LARGE-SCALE PROJECTS

The Division has vast experience in construction and modernization of the existing signaling infrastructure. Some of the largest projects of the Division in the signaling field implemented on the JSC RZD network are:

- modernization of Baikal-Amur and Trans-Siberian railway lines by increasing their traffic and carriage capacity (I and II stages);
- increasing the capacity of the Artyshta—Mezhdurechensk—Taishet section of the Krasnoyarsk Railway;
- Increased traffic and carriage capacity of the infrastructure to maximize transit container flow by 4 times, including the "Transib in 7 days" project;
- development of the Moscow transportation hub;
- development and modernization of the railway infrastructure on the approach lines towards the ports of the North-West region.

The division is performing construction and installation, commissioning and capital repairs on the JSC RZD network, including the commissioning of computer-based and hybrid interlocking systems. More than 1,000 km of tracks, more than 1,000 structures and more than 100 stopping points have been built. Technical support of computer-based systems and devices has been performed on more than 5,100 infrastructure objects and on more than 4,700 elements of the signaling systems and devices.

Successful completion of the signaling and communication system modernization on the Trans-Mongolian mainline has clearly demonstrated the ability of the Signaling Division of GC NPS to implement any large-scale complex projects not only in Russia, but also abroad.

HIGH QUALITY WORK

The Signaling Division of GC NPS has specialists able to provide high-quality construction and installation works related to implementation of new and modernization of the existing station and wayside signaling and communication equipment. In addition, recycling service for the signaling equipment that is out of service is provided.

MAINLINE
solutions

The Signaling Division of GC NPS has a wide range of in-house systems and devices to satisfy all customers requirements for safe train operation and efficient traffic management on the mainlines.

INNOVATIVE TECHNICAL SOLUTIONS

In recent years, the companies of the Signaling Division of GC NPS have implemented comprehensive world-class projects within the "1520 area":

- equipping new railway lines in Kazakhstan with the radio-based train control systems, computer-based interlocking systems, semi-automatic line block systems, axle counter systems, centralized traffic control, as well as equipping locomotives with the onboard safety devices;
- in addition to the technical solution implemented in Kazakhstan, the hybrid interlocking components (relay object controllers) were used to upgrade the Trans-Mongolian Railway, while maintaining the operating wayside equipment and relay-based interlocking. Thus, the viability of a radio-based train control system with moving blocks over the existing relay systems has been confirmed in practice, which opens up broad prospects for the rapid and efficient upgrading of the signaling systems in order to increase the capacity of the existing lines.

KEY TECHNOLOGIES AND PRODUCTS FOR MAINLINES

- Computer-based and hybrid interlocking systems.
- Relay and computer-based automatic and semi-automatic line block systems.
- Centralized traffic control, technical diagnostics and monitoring.
- Radio-based train control systems.
- Onboard safety systems.
- Track circuits and axle counter systems.
- Level crossing protection systems with wayside equipment.
- Cantilever and sleeper-mounted electric point machines.
- Signals, signs and indications.

ADVANCED SYSTEMS WITH TRADITIONAL TRAIN CONTROL TECHNOLOGIES

The computer-based hybrid and relay systems of interlocking and centralized traffic control are widely used within the "1520 area" and beyond, combined with various products of the Signaling Division of GC NPS: the automatic and semi- automatic line block systems, track circuits and axle counters, level crossing signaling, electric point machines, signals etc.

HIGH SPEED LINE
solutions

The Signaling Division of GC NPS is ready to offer technical solutions for High Speed and Very High Speed lines. They provide the ability of train control using fixed, virtual and moving block sections with a track-to-train data transfer via the track circuits and radio network.

INNOVATIVE SOLUTIONS FOR THE RUSSIAN HIGH SPEED LINES

The Signaling Division of GC NPS together with JSC NIIAS has developed an Integrated Train Control System for very high speed lines designed in Russia, which, in particular, includes:

- computer-based interlocking systems;
- computer-based automatic line block system with audio frequency track circuits and centralized equipment layout in the mounting racks of the ALB-MSh family, which ensures data transfer to the onboard devices via short track circuits and train control at speeds up to 250 km/h;
- radio block center of the train control system. The radio communication is used for data exchange with trains in order to traffic control at speed exceeding 250 km/h. In addition, fixed block sections are used for ensuring of the safe distances between high speed trains, and the ALB-MSh automatic line block system ensures the standby level.

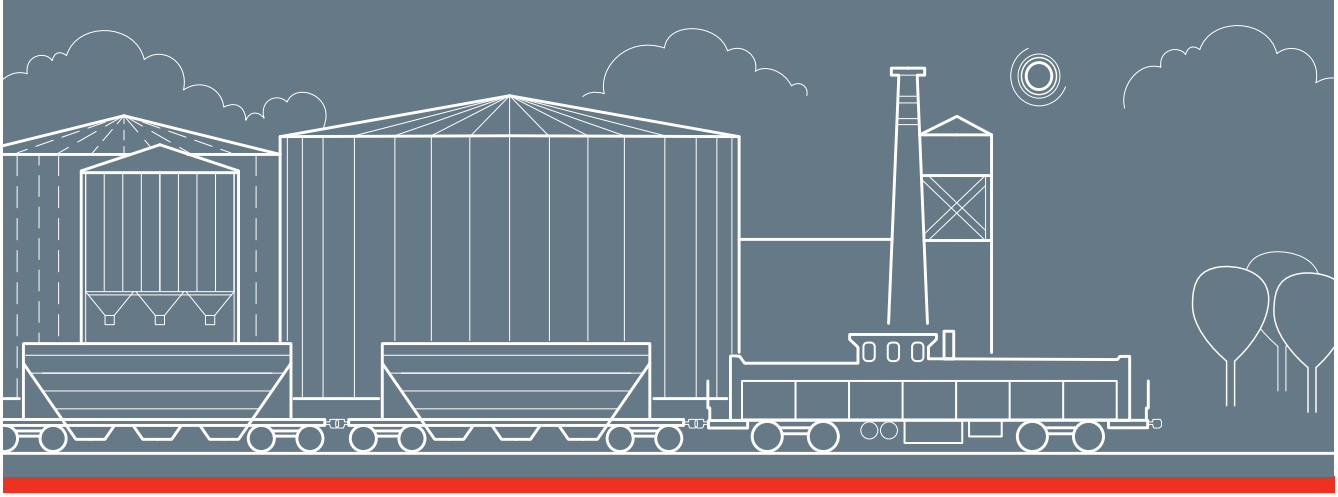
RADIO-BASED SOLUTIONS FOR GLOBAL MARKETS

The Signaling Division of GC NPS has gained great experience in application of radio block systems and creation of integrated control systems at polygons with a total length of more than 3,000 km.

KEY TECHNOLOGIES AND PRODUCTS FOR HIGH SPEED LINES

- Computer-based and hybrid interlocking systems.
- Computer-based automatic line block systems.
- Centralized traffic control, centralized traffic supervision, technical diagnostics and monitoring.
- Radio-based train control systems.
- Onboard safety systems.
- Track circuits and axle counter systems.
- Cantilever and sleeper-mounted electric point machines.

The Division has solutions allowing implementation of innovative control systems for Very High Speed traffic via a radio network with fixed (including virtual) block sections or moving blocks. They involve the Division's entire line of state-of-the-art computer-based systems, including the CBI, radio-based train control system, CTC system, axle counter equipment, etc.



INDUSTRIAL TRANSPORT

solutions

On industrial and mine railways, traffic is deeply integrated into the manufacturing process, and its effectiveness has direct impact on the product cost and the possibility to ramp-up the production. The Signaling Division of GC NPS delivers integrated radio-based train control systems, which can provide high security level, enhanced capacity and uninterrupted transportation under heavy production and climatic conditions with minimum investments.

INTEGRATED RADIO-BASED TRAIN CONTROL SYSTEMS

The innovative solution proposed by the Division is based on the radio-based train control system (RBTC) providing control of points, level crossings and other wayside objects, along with train control using moving block or virtual block sections, as well as digital interface with adjacent automated control systems (loading, unloading, balances, etc.).

The integrated system does not require signals and wayside track vacancy control devices (track circuits and axle counters), which significantly increases the system availability, reduces the investment and operating costs. The system ensures high automation level, up to full automatic train operation with unmanned locomotive.

The Division also proposes state-of-the-art solutions based on traditional technologies for Industrial Transport: the interlocking systems in combination with the automatic and semi-automatic line block system based on the axle counter or track circuits systems. The customer's relay interlocking systems and their connected wayside equipment can be kept and integrated into the system using the hybrid interlocking components, such as relay object controllers.

KEY TECHNOLOGIES AND PRODUCTS FOR INDUSTRIAL TRANSPORT

- Computer-based and hybrid interlocking systems.
- Relay and computer-based automatic and semi-automatic line block systems.
- Centralized traffic control, technical diagnostics and monitoring.
- Radio-based train control systems.
- Onboard safety systems.
- Track circuits and axle counter systems.
- Level crossing protection systems with wayside equipment.
- Cantilever and sleeper-mounted electric point machines.
- Signals, signs and indications.

MASS TRANSIT
solutions

The Signaling Division of GC NPS cooperates actively with the Moscow Metro, which is one of the busiest and heavily used mass transit rail transport systems in the world. The systems and devices of the Signaling Division of GC NPS used at the Moscow Metro are characterized by the high level of safety, availability and reliability, which allows ensuring the metro traffic with intervals of less than 90 sec in peak hours.

COMPUTER-BASED AND HYBRID INTERLOCKING SYSTEMS AND SOLUTIONS FOR CENTRALIZED TRAFFIC CONTROL

The interlocking systems designed for metro provide hot standby for all electronic components, including object controllers, as well as redundancy for all communication channels and track circuit electronics. This ensures maximum operational availability of the whole complex of signaling systems and devices for metro. This itself becomes a safety factor for the critical mass transit transport infrastructure.

The interlocking systems for the Moscow Metro implement the unified interface for all users and the ability to connect to the unified Centralized Traffic Control system. Due to the Metro specifics, electronic modules of the interlocking systems feature a dust-proof design.

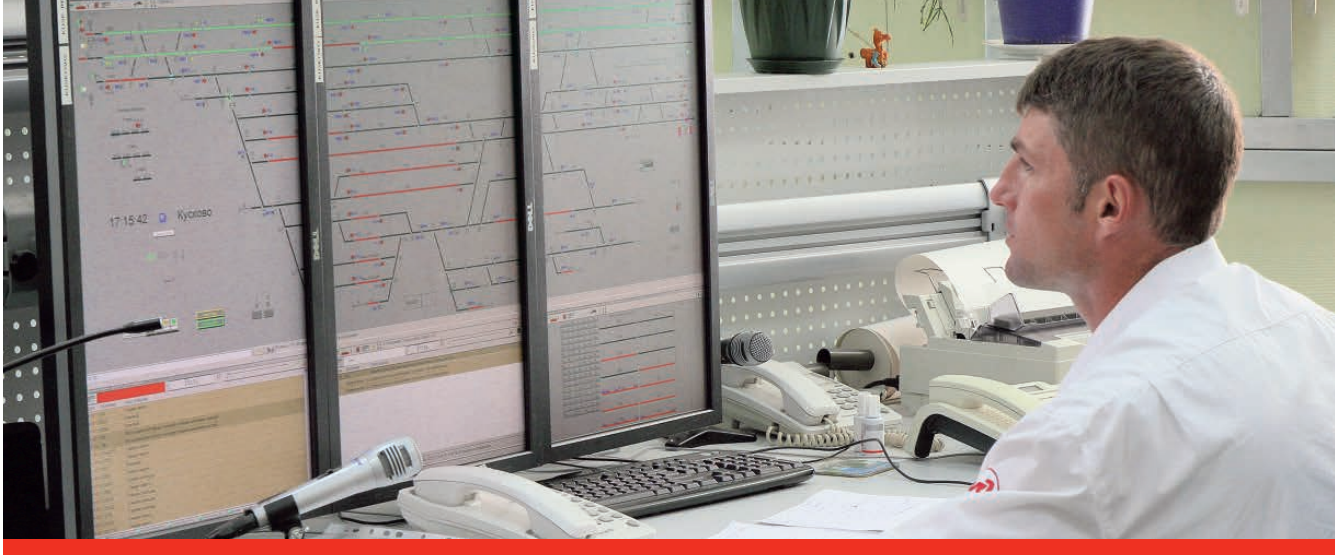
Moscow Metro widely uses reliable and functional digital track circuit monitoring modules with the audio frequency track circuit encoding by the Automated regulation of speed (ARS) frequencies. These modules are linked with computer-based systems via digital or relay interface.

KEY TECHNOLOGIES AND PRODUCTS FOR MASS TRANSIT

- Computer-based and hybrid interlocking systems.
- Automated remote control system for metro trains.
- Track circuits and axle counter systems.
- Automated workstation system.
- Enhanced cybersecurity systems.
- Cantilever and sleeper-mounted electric point machines.
- Signals, signs and indications.

The interlocking systems are complemented by the cybersecurity systems, connected to the remote monitoring workstations in a unified metro control center, and protect the CBI internal network against cyber attacks from external communication networks.

The Division's automated remote control system for metro trains, together with other signaling systems and devices provides a comprehensive technical solution capable of increasing the level of automation and the efficiency of the transportation process on metro lines of any configuration.



INTERLOCKING SYSTEMS

of the Signaling Division of GC NPS

The Signaling Division of GC NPS successfully supplies the RAIL Lock family of interlocking systems capable to satisfy any customer's needs and complete all safe control tasks for signaling wayside devices at stations and blocks. The Division's computer-based interlocking systems are in operation at more than 700 stations in Russia and abroad already.

Cabinets with object controller of the CBI-E computer-based interlocking system

FLEXIBLE ARCHITECTURE

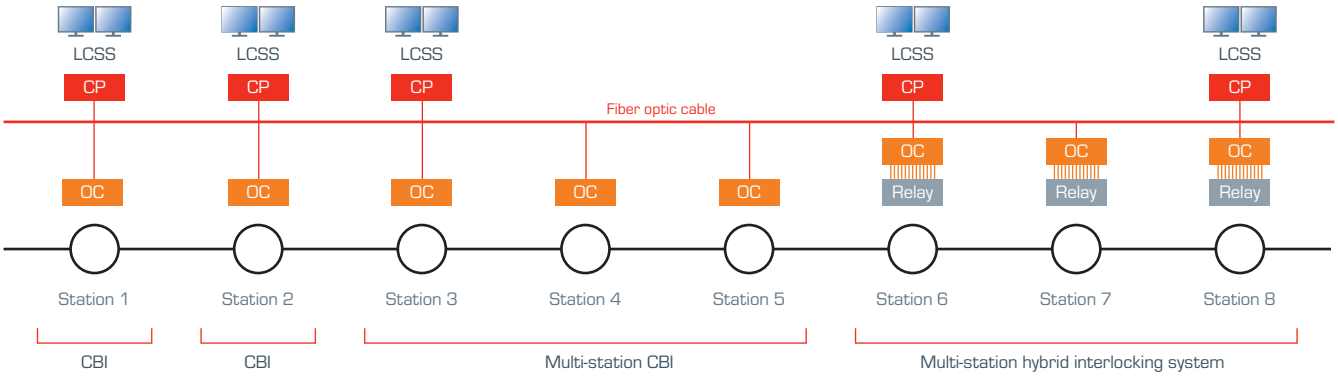
The Division's RAIL Lock interlocking family includes computer-based systems CBI-E, CBI-EL, CBI-MZ-F, CBI-SM and hybrid interlocking systems RBI-E and RBI-EL, which allow customers to migrate to digital technology step-by-step, and at a low cost. The RBI-E and RBI-EL systems allow configuring with various proportions of relay and computer-based modules in specific projects. This allows choosing the best configuration for the customers based on their budget and the existing equipment.

The Division has developed and already implemented the new generation of computer-based interlocking based on a digital Platform 2.0.

MULTI-STATION SYSTEMS

Design flexibility of interlocking systems is also demonstrated in the possibility of creating multi- station systems with central processors located only at one or two stations of a long span, while other stations are equipped just with object controllers.

The Division has widely used these systems at several railway lines in Russia and Kazakhstan. The RBI-E and RBI-EL systems allow using multi-station design, which is especially effective, if the customer wants to preserve some of the current relay equipment at the stations, while increasing capacity and expanding functionality of the signaling equipment at minimum costs. An example of this design is a hybrid system on the Trans-Mongolian mainline.



Configuration examples for the RAIL Lock interlocking systems

QUICK PROJECT IMPLEMENTATION

The Signaling Division of GC NPS applies the most advanced development and debugging tools to force the system adaptation to the specific project conditions, to upgrade individual modules for specific customer needs, if required, and to verify all the dependencies at the factory.

HIGH RELIABILITY

The interlocking systems include carefully selected components and hot standby components with the ability to select the desired availability level for a specific project. For example, interlocking systems can be configured with the minimum required redundancy level for stations within the low-density traffic lines and at some industrial transport facilities, or with hot standby of all components for other projects.

MINIMIZING LIFE CYCLE COST

The interlocking systems are designed to minimize the costs over the entire life cycle. They have integrated advanced diagnostic tools that provide detailed information on the equipment conditions to operators and technical personnel.

All the Division's computer-based interlocking systems provide monitoring of changes in operation parameters for electric point machines, signals and other wayside devices, which allows identifying timely their pre-failure condition and switch from regular maintenance of the devices to condition-based maintenance.

KEY BENEFITS OF THE DIVISION'S INTERLOCKING SYSTEMS

- Extremely flexible design with the ability to configure centralized and distributed systems.
- Enhanced functionality.
- Integration of control over the wayside signaling and interlocking devices in one station processor device.
- Easy docking with higher-level control systems via a digital interface.
- Integration with shunting automatic cab signaling (ATP).
- Reduced scope of construction and installation works.
- Reduced traffic prohibiting time when changing the station layout and associated dependencies between the points and signals.
- Possibility to control objects at many stations and blocks from one workstation.
- Advanced diagnostics.
- Reduced life cycle costs.

HIGH CYBERSECURITY LEVEL

The Signaling Division of GC NPS is one of the first in the industry to develop an information security complex that allows monitoring the interlocking systems from an external network.

COMPUTER-BASED INTERLOCKING SYSTEMS

CBI-E and CBI-EL

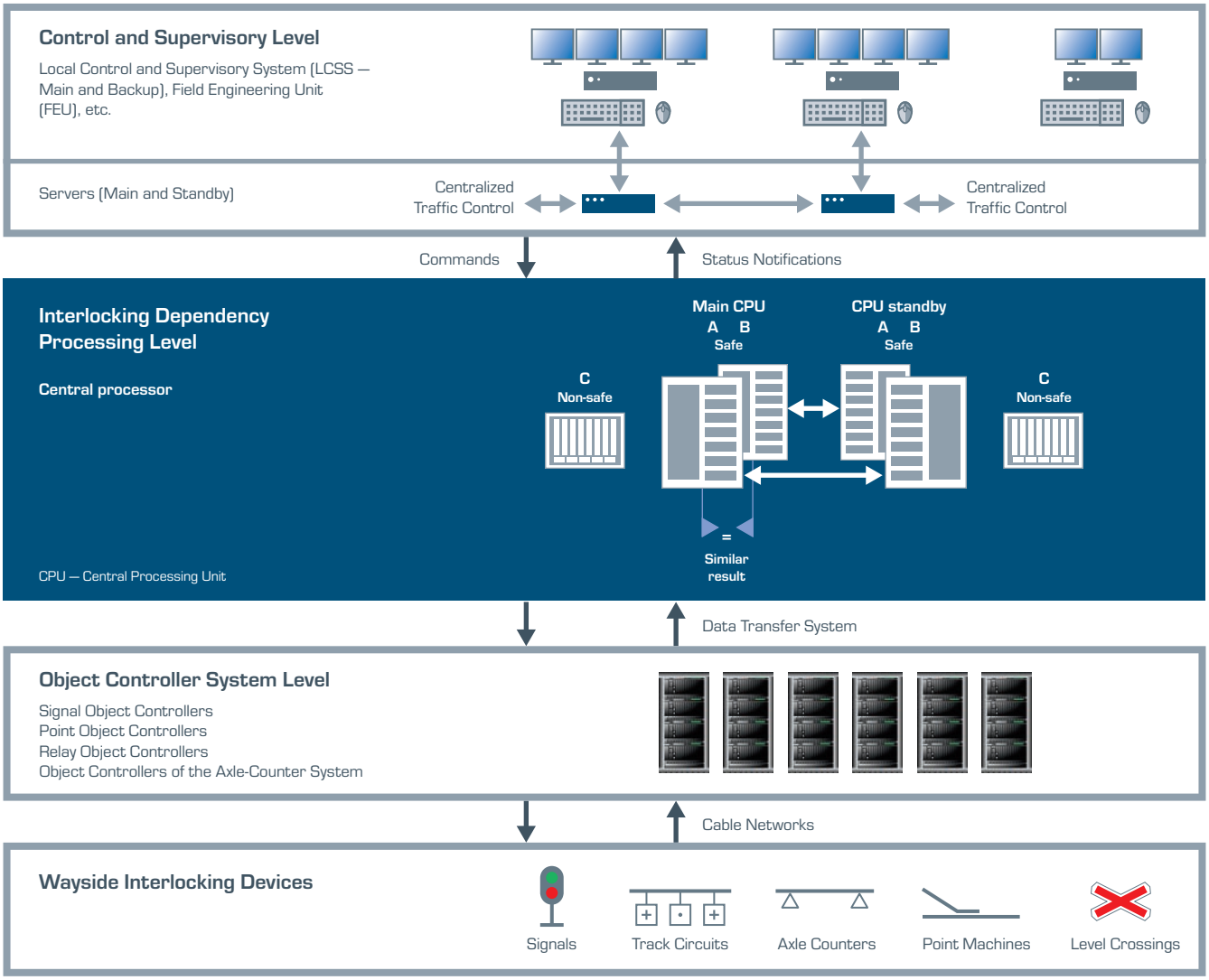
CBI-E and CBI-EL are the most common computer-based interlocking systems with advanced functionality within the "1520 area". They are implemented at more than 700 stations, including more than 400 stations of the Russian Railways.

The CBI-E computer-based interlocking system is based on foreign components. The Signaling Division of GC NPS has developed its modification CBI-EL made entirely from Russian components. Both designs of the computer-based interlocking system are fully adapted to the "1520 area" railway requirements.

ARCHITECTURE OF CBI-E AND CBI-EL

CBI-E and CBI-EL systems consists on three levels. Data exchange between the layers and system components is implemented via high-performance

CBI-E system architecture



redundant Ethernet networks using standard TCP/IP protocols. The top level of control and monitoring is formed by the local control and supervisory system (LCSS). Power supply is ensured through the reliable PUSHP-E power supply unit, and the lightning protection is ensured by surge protection devices (SPDs).

CENTRAL PROCESSOR

Central processor of the CBI-E and CBI-EL systems ensures:

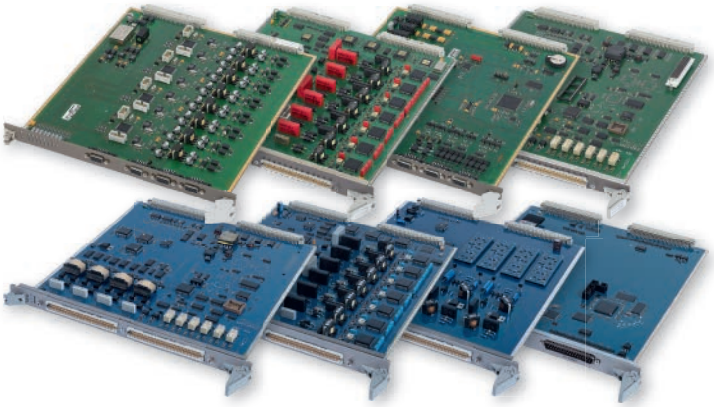
- conversion of commands from the control system into those transmitted to the wayside devices;
- object locking in the route;
- automatic and forced route release;
- other interlocking functions.

The central processor consists of two industrial computers, one of which is in hot standby. Each computer processes the critical data using two channels and 2oo2 scheme. The safe computing channels use processors with different architecture, different operating systems and diversified application software. The central processor integrates semi-automatic and automatic line block functions.

The operating range of the CBI-E central processor can include more than 2,000 logical objects. The central processor can be delivered in a sealed enclosure without internal and external cooling/ventilation systems and can be installed in an outdoor climate control cabinet enclosure maintaining stable operation of the system in the most harsh environments.

SYSTEM OF OBJECT CONTROLLERS

Object controllers of the CBI-E and CBI-EL systems are connected to signals, points, level crossings, track circuits, axle counter systems, etc. via an electronic interface. Each object controller can control several wayside devices and can be installed either in the same room with the central processor or remotely, in the immediate vicinity of the controlled wayside devices. The object controllers are designed for a wide range of air temperatures and relative humidity values.



Object controller boards of the CBI-E (top) and CBI-EL (bottom) systems

Design of central processors of the CBI-E and CBI-EL systems

UNIVERSAL DIGITAL PLATFORM 2.0

for CBI and other signaling systems

CyberTech-Signal, company of the Signaling Division of GC NPS has developed a safe digital Platform 2.0, which can be used as a base for train control and safety systems, as well as for automated control systems for other industries. Innovative software and hardware approaches make Platform 2.0 a versatile, flexible and technology-independent solution.

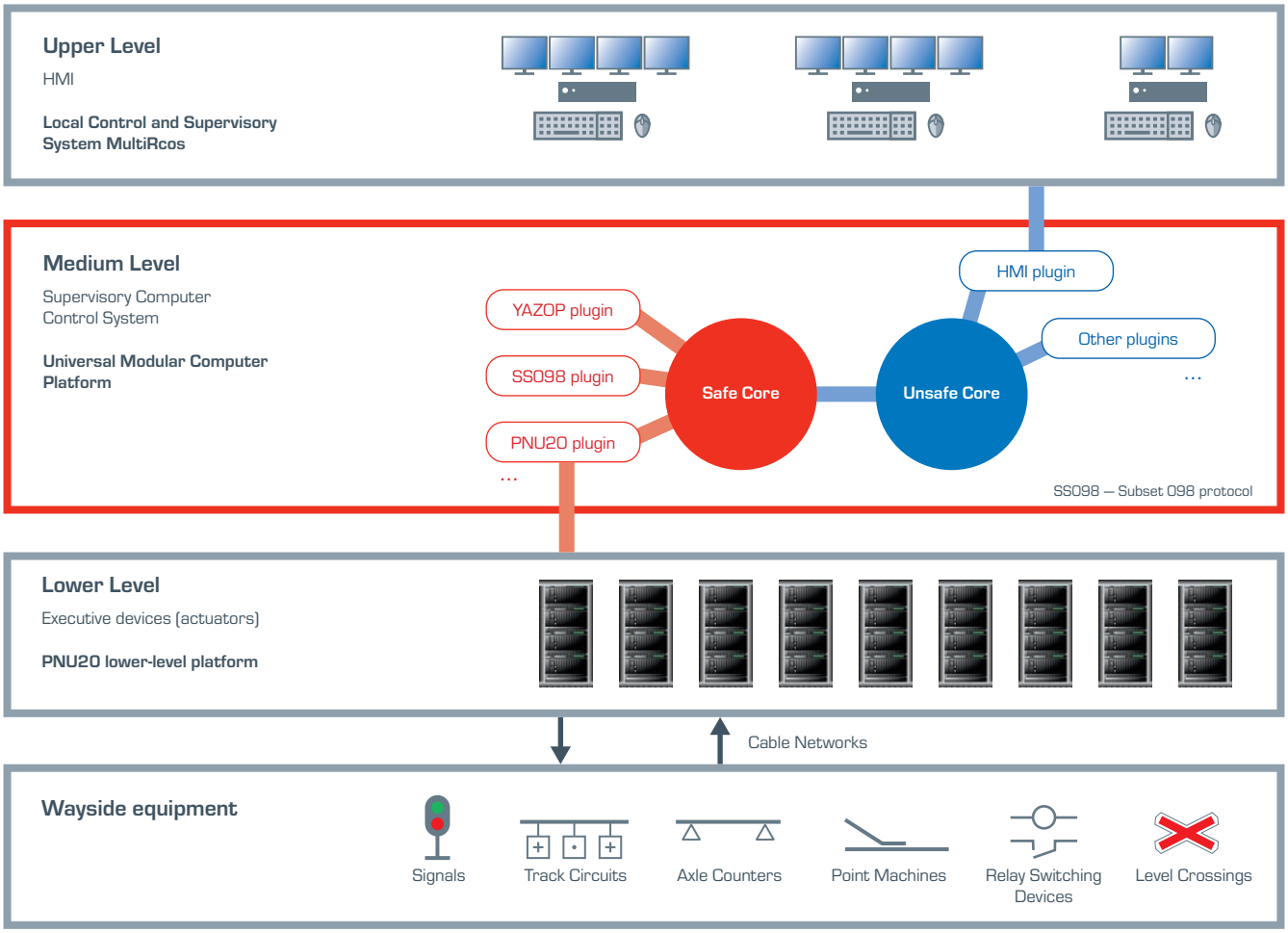
Compared to existing solutions, Platform 2.0 is the next-generation system featuring maximum scalability (thanks to its modular structure), drastically higher performance rate due to an innovative event-driven approach and enhanced functionality, including diagnostic capabilities.

GENERAL CONCEPT OF PLATFORM 2.0

Platform 2.0 is a three-level structure. The **upper level** uses a cross-platform local control and supervisory system MultiRcos, which can run within a range of operating systems: Russian RED OS, Windows, as well as in any Linux-like POSIX-compatible operation systems.

The **medium level** is implemented by the VMK20- MTs supervisory computer control system (SCCS), which

Structure of Platform 2.0 designed for rail transport and used in a computer-based interlocking (as example)



hardware is based on a universal modular computer platform. It uses the Elbrus operating system. The basic software of the supervisory computer control system is arranged as a system of separate plugins, which function and communicate via a safe core. These plugins implement the interlocking logic, communication with LCSS and object controller systems, as well as other safety-related and non-safety-related functions. This design reduces costs of the basic software development and adaptation for a specific project.

The technology software allows safe dependency calculation and includes two components. One of them describes specific control objects, while another specifies the relations between the objects based on their geography, i.e. gives a description of a certain station.

The **lower level** is implemented by the PNU20 platform, which uses Object Interface Units that control points, signals, relays, etc.

UNIVERSAL MODULAR COMPUTER PLATFORM

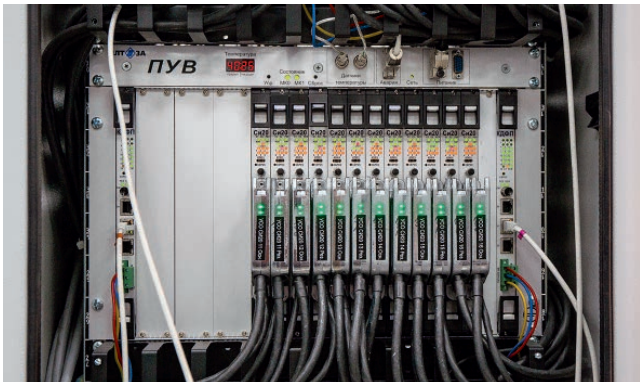
Universal modular computer platform consists of a frame carrying a power supply, communication module and a set of processing modules. Its safety is ensured by the usage of two channels and 2oo2 scheme. The processing modules are built on Russian processors, but can use other processors including those with the ARM architecture.

PNU20 LOWER-LEVEL PLATFORM

The PNU20 lower-level platform is made of a frame carrying two LAN cards and Object Interface Units cards made using Russian hardware. All cards support hot standby capability.

For the PNU20 platform, there are developed various types of Object Interface Units, all of them being universal. For example, a point's Object Interface Unit can control a point (or coupled points) via a two-, three-, five-, seven- or nine-wire connection, while Object Interface Unit intended for signals can control six lamps of a signal.

Universal modular computer platform



PNU20 lower-level platform

Cards of the PNU20 lower-level platform

PLATFORM 2.0 IMPLEMENTATION

Platform 2.0 has obtained a Certificate of Compliance with the Safety Integrity Level 4 (SIL4). The software of Platform 2.0 has successfully passed audit of information security and is included in the official Register of Russian Software. Since the December 2022, the Platform 2.0 based CBI-EL system is used at the Northern Railway's Panteleyevo station.

COMPUTER-BASED INTERLOCKING SYSTEM

CBI-MZ-F

The CBI-MZ-F computer-based interlocking system features high flexibility and versatile design allowing quick adaptation to a hardware platform required by a specific project.

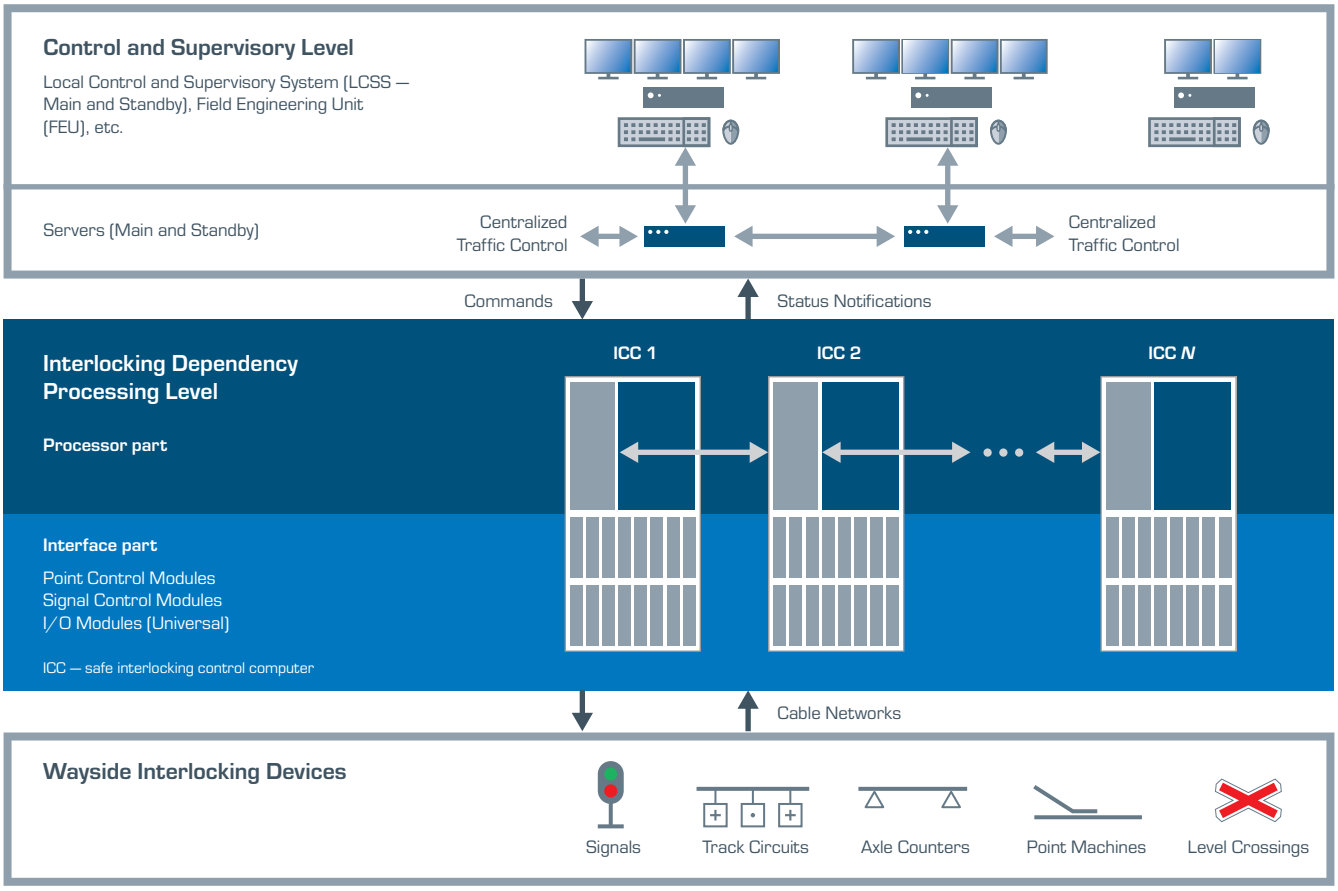
The system can be deployed on various platforms using both Russian and foreign hardware. The CBI-MZ-F system is fully compatible with the interlocking centralized equipment and wayside devices used within the "1520 area". The system's software is designed by the specialists of the Signaling Division of GC NPS in accordance with the Russian Railways' requirements and is suitable for operation on other railways of the "1520 area".

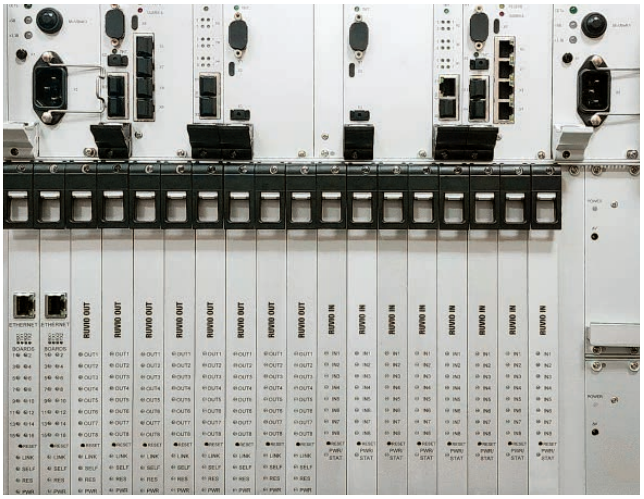
DESIGN OF THE CBI-MZ-F SYSTEM

Design of the CBI-MZ-F system consists of two main levels. The control and monitoring level covers the main and backup LCSS and FEU. Data exchange between control computers, LCSS, and the adjacent signaling systems and upper-level control systems is implemented via redundant servers.

The dependency processing level consists of one or more secure interlocking control computers (ICC). Each computer is responsible for a specific interlocking area. This design ensures high system tolerance to any hardware faults. Even if one ICC will fail completely, the operation can be continue in other areas of the station.

Design of the CBI-MZ-F system





Design of CBI-MZ-F based on a Russian hardware platform

A majority voting logic is implemented at the dependency processing level. All responsible commands are executed only in case of complete coincidence of the processing results between at least two processor modules. At the same time, an ICC can use various connection schematic for the computing channels, which operate in parallel. Data exchange between the different ICCs is based on industrial communication protocols.

For connection with controlled and monitored objects, the CBI-MZ-F system implements relay contact and contactless interface functionality.

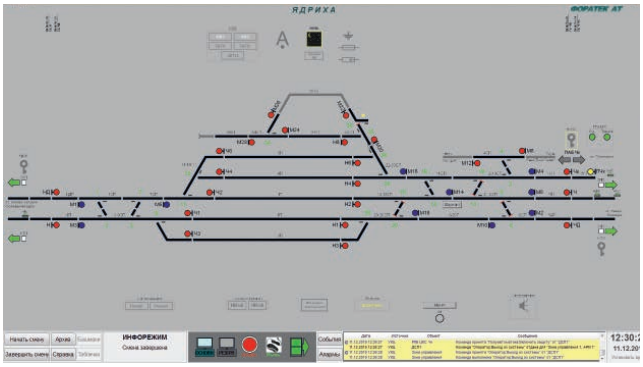
SOFTWARE

The CBI-MZ-F software is based on a unique proprietary technology and ensures the system's independence from a specific hardware platform.

This makes construction and upgrade of the interlocking systems significantly easier and faster, while allowing personnel without programming skills to develop and configure the software.

In the context of the active railway development, quick creation and modification of the technology software makes it possible to reduce the CBI implementation

Design of CBI-MZ-F based on a foreign hardware platform



Local control and supervisory system interface in the CBI-MZ-F

time at new and modernized facilities. Connection of the existing wayside equipment and related relay circuitry to the CBI-MZ-F system during a step-by-step station upgrade helps reducing the railways' investment costs.

Freedom to choose the appropriate hardware platform maximizes the system architecture's flexibility and adaptability for the various customer requirements and allows using CBI-MZ-F in international projects at the foreign signaling and telecommunication market.

COMPUTER-BASED INTERLOCKING SYSTEM

CBI-SM for metro

The computer-based interlocking CBI-SM system was developed specifically for the metro by Stalenergo Ltd. — one of the Signaling Division entities. This modular system has extremely short response time, flexible architecture and can be easily adapted for any specific project.

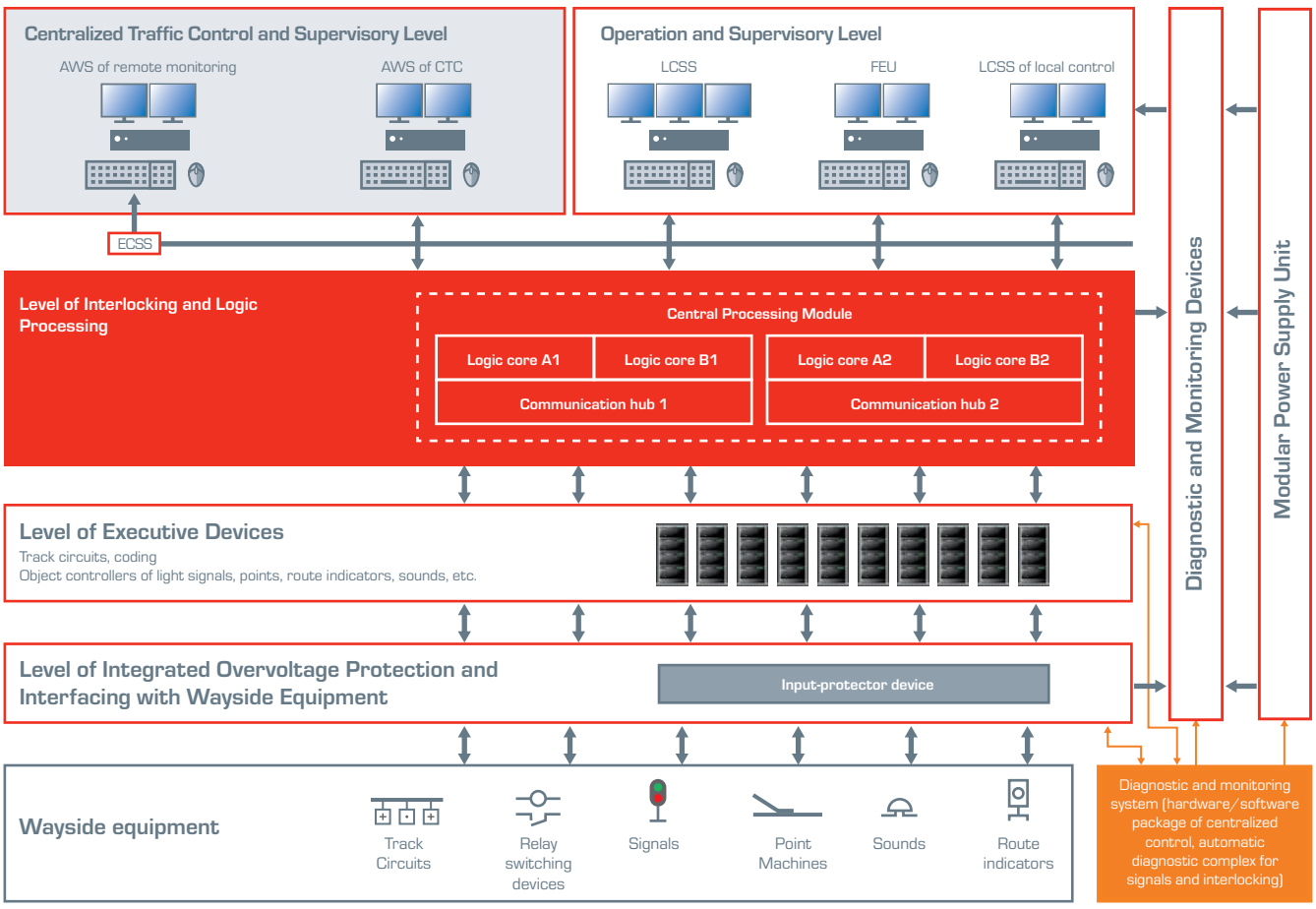
The computer-based interlocking system CBI-SM is designed for the inter-station metro line sections, stations (including stops without additional tracks) and in the electric depots both during new construction and modernization or reconstruction of signaling devices. CBI-SM can be deployed in several stages with a gradual increase in its functionality.

HIGH-SPEED AND RELIABLE SYSTEM FOR METRO

The CBI-SM system meets the most tough requirements of the metro with high intensity of traffic:

- capacity is at least 48 trains per hour per direction;
- more than 1000 logical control objects (track circuits, points, signals, etc.);
- object controller data exchange cycle with provision of the detailed hardware and software diagnostics: no more than 0.15 sec;
- full data exchange cycle: no more than 0.45 sec;

Structure of the CBI-SM system



ECSS Enhanced cybersecurity system

- mean time between failures of CBI-SM (T_0) is at least 50 thousand hours;
- 100% redundancy at all levels;
- protection from unauthorized access and erroneous command execution.

THE CBI-SM ARCHITECTURE

CBI-SM consists of the following functional levels and subsystems:

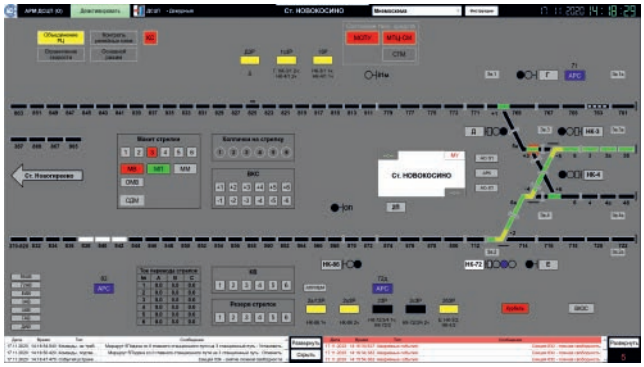
- operative control and supervisory level with local control and supervisory systems of operators and technicians (LCSS, FEU, LCSS of signaling operators);
- the level of signaling and logical processing of data, where the central processing module is located;
- the level of executive devices (track circuits, ARS (Automated Regulation of Speed) coding, object controllers);
- the level of integrated overvoltage protection and interfacing with wayside equipment;
- the subsystem for diagnostics and monitoring of the CBI-SM components;
- uninterrupted power supply subsystem.

There is no option to use any dedicated computers in the central processing module functioning under operating systems. For the first time in world practice, CBI-SM uses programmable logic devices (PLDs) to implement the inter-dependency logics of its managed and controlled objects, which allows avoiding reliability and security risks related to computer hang, unpredictable operating system's reaction to emergencies, hacking and undocumented features. Communication with external systems is arranged via a digital or relay interface.

At the level of executive devices (track circuits, ARS coding, object controllers), there is used a brand new safe circuitry of digital signal shaping and processing with self-diagnosis functionality, which eliminates any safety risks in case of semiconductor and relay elements failure.

An innovative monitoring and diagnostics subsystem takes the CBI-SM system maintenance and operation

Object controllers boards of the CBI-SM system



LCSS interface of the CBI-SM system

to the qualitatively new level. It provides event archiving, graphical visualization of the monitored parameters, and an intuitive interface using web technologies.

IMPLEMENTATION IN THE MOSCOW AND TASHKENT METRO

The CBI-SM computer-based interlocking system has been successfully tested in trial operation at the Novokosino station of the Moscow Metro.

In Tashkent Metro, six stations of the Sergeli line opened in December 2021. Moreover, since 2022 CBI-SM is deployed at 14 stations of the elevated Circle line "30th Anniversary of Independence of Uzbekistan" featuring a multi-station design — one CBI package per two metro stations. All stations are interconnected via digital communication with two fiber optic lines for each link, while the CBI-SM connection with the "Dialog" automated centralized traffic control system is made through a digital interface.

HYBRID INTERLOCKING SYSTEMS

RBI-E and RBI-EL

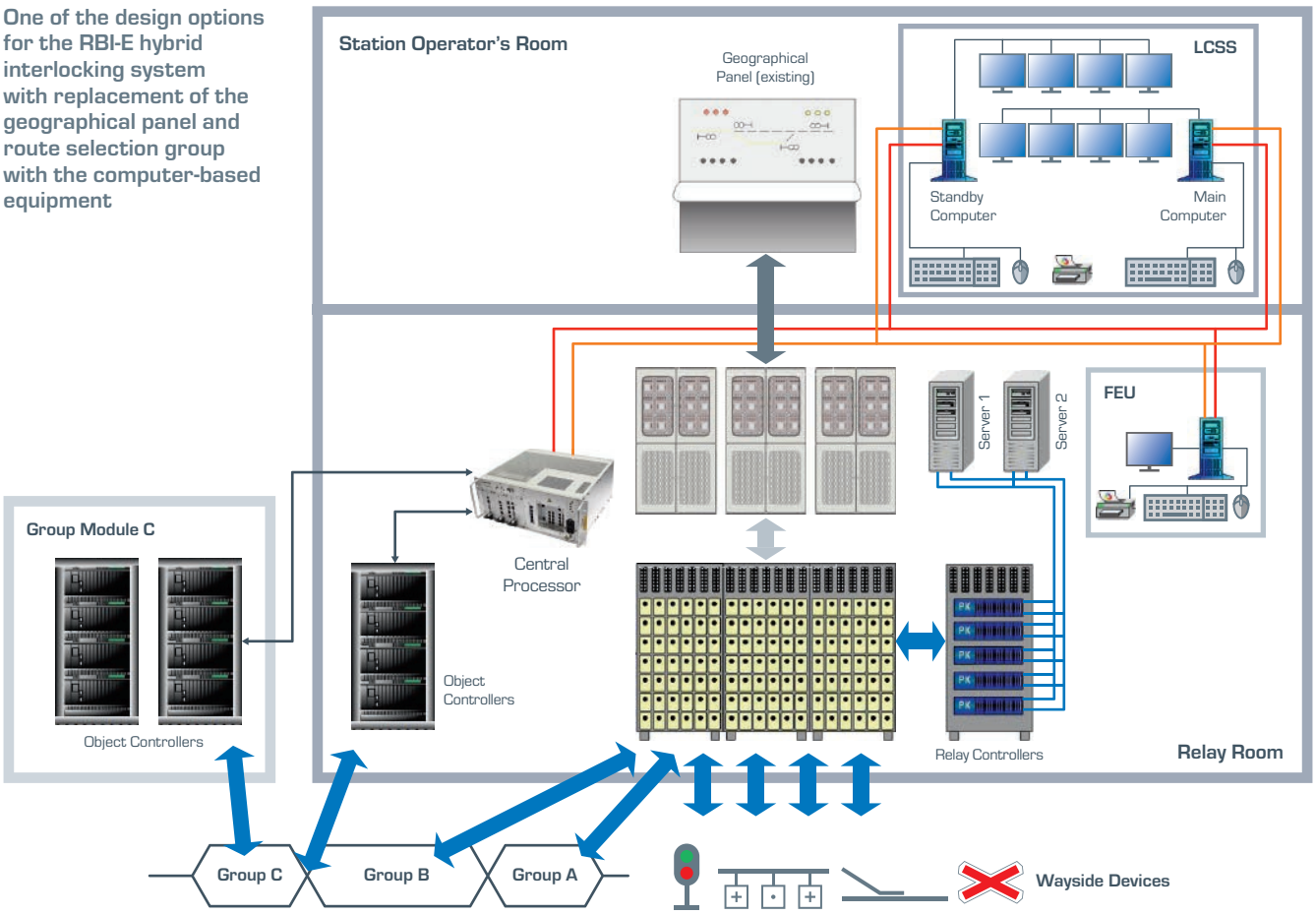
The RBI-E hybrid interlocking system and its modification RBI-EL based on a Russian hardware platform allow updating the interlocking devices step-by-step, without significant one-time investments, while keeping the existing cable networks and wayside equipment. At the same time, a quick effect is ensured even from a partial introduction of digital technologies.

FLEXIBLE DESIGN FOR UPGRADING LARGE, MEDIUM AND SMALL STATIONS

The RBI-E system allows switching to the computer-based equipment and a state-of-the-art ergonomic Local Control and Supervisory System (LCSS) in case of a limited budget for upgrading or new construction of stations. Gradual replacement of the relay components with the computer-based ones is possible at the next stages. Introduction of the RBI-E system is also reasonable, when the existing relay system functionality does not meet the increased requirements.

Relay object controllers are used for sharing data from the controllers between the RBI-E server and the CBI central processor. If required, a backup control panel can be kept, for example at stations with two control panels. If only wayside equipment is to be kept, a design with all dependencies implemented in the central processor, while relay object controllers manage

One of the design options for the RBI-E hybrid interlocking system with replacement of the geographical panel and route selection group with the computer-based equipment



the wayside objects via a relay interface. The RBI-E hybrid interlocking system includes the automated workstations, the CBI-E or CBI-EL components, the power supply unit and the SPD- based lightning protection.

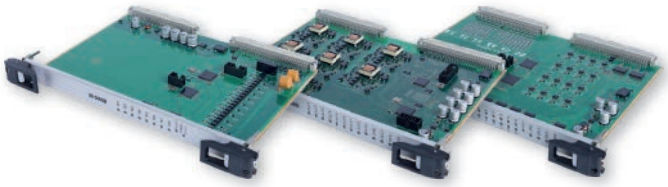
SAFE RELAY OBJECT CONTROLLERS

For effective use of the hybrid interlocking hardware, the Signaling Division of GC NPS has developed a new-generation safe relay object controller. The relay object controller can operate in a redundant configuration, providing up to 64 connection points for critical relay inputs and/or outputs.

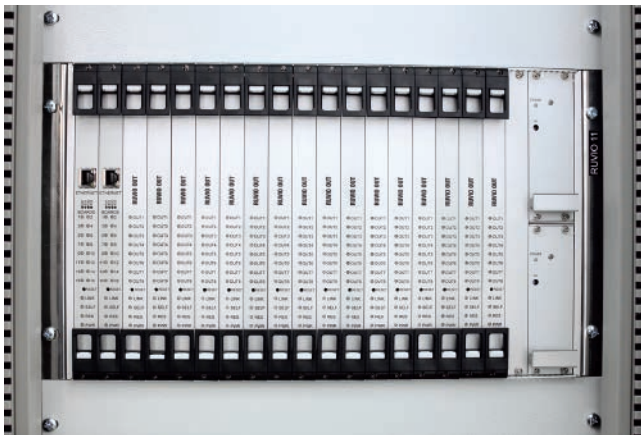
The relay object controllers ensure short response time. This means that time from the command received from a higher-level control system to the output voltage switching (on/off) or from complete closing (opening) the monitored relay contact to its registration by the critical input board does not exceed 100 ms. The relay object controllers can be mounted in cabinets or directly on relay racks.

MAIN ADVANTAGES

- Reconstruction of stations with any number of points.
- Unified and state-of-the-art Local Control and Supervisory System (LCSS).
- Automated route assignment from the LCSS.
- Flexible reconfiguration of control areas of several operators during peak hours.
- Enhanced labor performance of a station operators and technicians due to the introduction of state-of-the-art workstations, detailed reference information and a help system.
- Performing all the functions of the full-fledged computer-based interlocking system at the higher level (advanced diagnostics, archiving, logging, digital interface with external microprocessor systems of centralized control, ATP, diagnostics, etc.).
- Implementation of the entire operating logics in the central processor and object controllers of the computer-based interlocking system.



Boards of the RUVIO safe relay object controller



Safe relay object controller

Local Control and Supervisory System (LCSS) in the RBI-E hybrid Interlocking system

- Keeping all wayside equipment, including track circuits, with minor changes in the encoding schematics.
- Switching to the RBI-E within the shortest time period. Free relay contacts are used in installation, and all checks are performed before turning on the devices.
- During the further station equipment with the CBI devices, most of the existing equipment (workstations, servers, central processors and communication network) is kept.

COMPUTER-BASED HUMP-YARD INTERLOCKING

and control system

The computer-based hump-yard interlocking and control system AS-ARS from the Signaling Division of GC NPS is a key component of the railway yards automation package. It can be implemented on the newly constructed and existing mechanized and automated humps with high, medium and low capacity.

SYSTEM STRUCTURE

The system features a three-layer structure including the following:

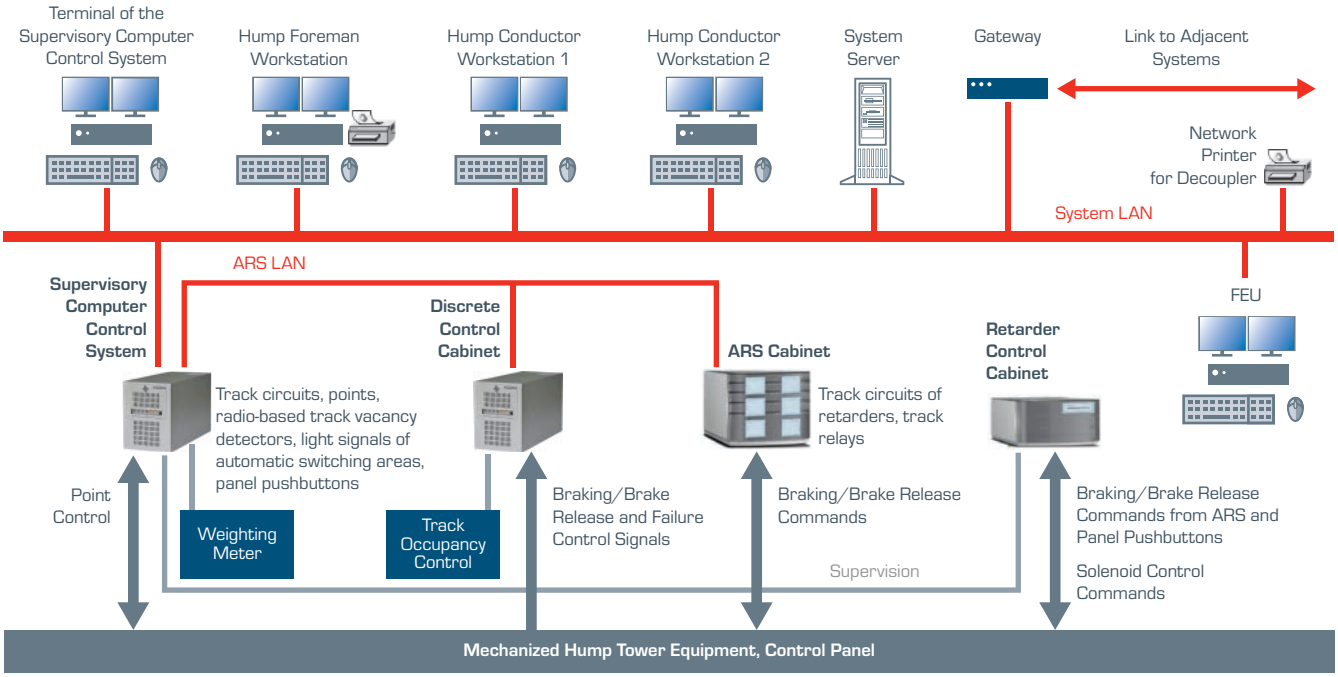
- the top level of centralized control and supervision with the workstations of the hump foreman, hump conductors, FEUs, backup control workstation of the lower-level platform, etc.;
- supervisory computer control system (SCCS) with hot standby capability;
- microcontrollers of car retarders for one or more retarder positions.

Such structure allows flexible expansion of the AS-ARS increasing the number of the network workstations and enhancing the system functionality. The AS-ARS system includes four functional subsystems:

- subsystem of point control of the automatic switching AS;
- subsystem of automatic retarder control (automatic regulation of speed) of the interval retarder position ARS IRP;
- subsystem of track vacancy control (TVC-KV hardware/software package);
- subsystem of automatic yard retarder control (automatic regulation of speed) ARS YRC.

The basic configuration for deployment includes the AS subsystem, while the other subsystems (ARS IRP, TVC-KV hardware/software package, ARS YRC) can be added depending on the customer's requirements to the hump automation scope.

Structure of the AS-ARS computer-based automatic switching system for humps



Any configuration of the AS-ARS system realize functions of monitoring, diagnostic and logging for the system and controlled objects. The system operates in continuous 24/7 automatic mode.

MAIN FUNCTIONS

- Automated implementation of the assigned routes during the detaching (distribution), ensuring their collection and correction both before and during this process.
- Implementation of the assigned cut delivery speeds from spacing and target retarder positions.
- Implementation of the permissible cut collision speed in the break-up yard.
- Monitoring and diagnostics of the facility and system hardware.
- Monitoring and logging of the work process.
- Data exchange with the adjacent systems.

Depending on the level of the facility's automation, the system controls train splitting either in a software mode with the yard operation list coming from the yard automated control system (ACS-Y), or in a routing mode with the manual preparation of the yard operation list by the operator.

After the detaching (distribution) is complete, a protocol is generated automatically to monitor the implementation of the set yard operation list and the system operation mode. Hump foreman can correct the executed yard operation list, if shunting operations took place during or after the automated distribution.

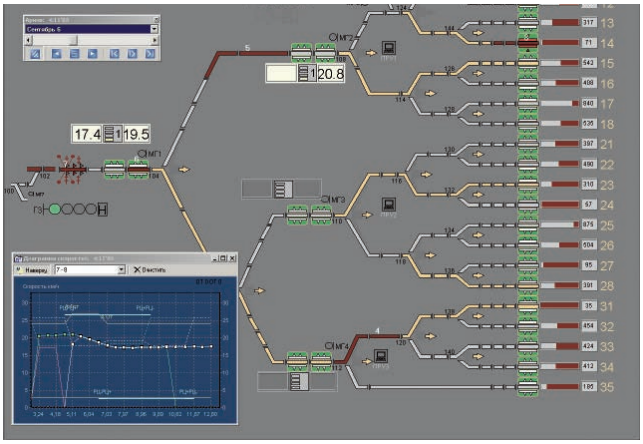
CONTINUOUS DEVELOPMENT

The AS-ARS system develops continuously. In the AS subsystem, there was a switch from relay technology to a computer-based hump switching CBHS. To improve the hardware availability, there are provided redundant supervisory computer control systems and operators' workstations.

Application of the axle counter sensor instead of track circuits provides better positioning of the cut ends, monitoring of the car (wagon) number and throughput rate. There was introduced a car- based cut model, which allows flexible processing of events like cutting failure and manual cut disengagement by the decoupler.

MAIN ADVANTAGES OF THE AS-ARS SYSTEM

- Flexible modular structure.
- Scalability and functional expandability.
- Hot standby of the main modules to enhance the system availability.
- Easy system adaptation to the customer requirements concerning the level of the facility's automation.
- Easy linking with the adjacent systems such as the yard automated control system (ACS-Y), hump automatic cab signaling (HACS R), etc.
- Quick and easy transition from automatic to manual control mode.
- Integration of axle counters and other state-of-the-art signaling means like photoelectric/IR devices, indicators of the train cut rolling-down speed, etc.
- Advanced diagnostics.
- Reduced life cycle costs.



FEU of the AS-ARS system at the Minsk-Sortirovochny station

SYSTEM IMPLEMENTATION

The AS-ARS automatic hump switching system is deployed at 14 railway yards in Russia, Belarus and Kazakhstan.

COMPUTER-BASED SEMI-AUTOMATIC LINE BLOCK SIGNALING

Semi-ALB-E and Semi-ALB-EL

The Semi-ALB-E and Semi-ALB-EL systems based on the CBI components are designed for low-density traffic lines and can increase their capacity when the intermediate block cabinet are intalled between two stations. They are two modifications of a semi-automatic line block system, the latter based on a Russian hardware platform.

MAIN FUNCTIONS

- Monitoring the open line condition.
- Obtaining consent for train departure.
- Open line locking.
- Open line release.
- Sending consent for train departure.
- Cancelation of consent for train departure.
- Safe departure of service trains.

ADVANTAGES

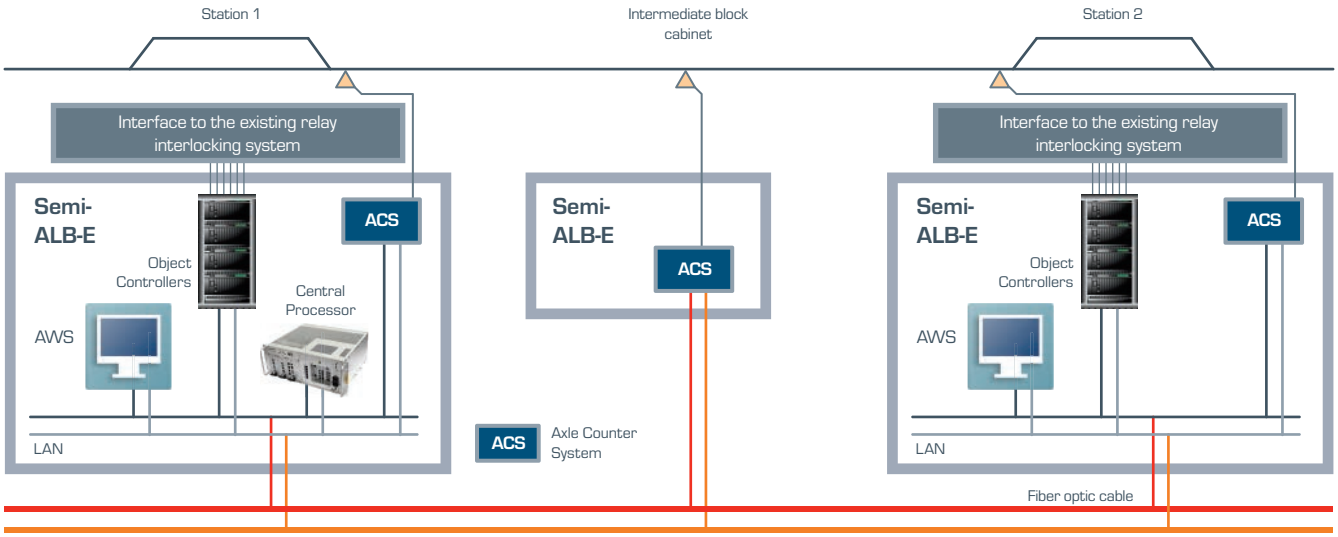
- Centralized equipment layout in compact cabinets at the adjacent stations.
- Data transfer via a digital channel.
- Implementation of both reference and centralized control.

Use of the axle counter system as the main device for open line vacancy monitoring in the Semi-ALB-E and Semi-ALB-EL systems gives some additional advantages:

- physical monitoring of the running line vacancy by counting the number of axles occupying and leaving the open line;
- automatic recording of the complete train arrival;
- less wayside equipment;
- reduced operating costs.

The semi-automatic line block system Semi-ALB-E on the Tashguzar — Kumkurgan section in Uzbekistan

Structure of Semi-ALB-E (design option with an intermediate block cabinet and axle counter system)



COMPUTER-BASED AUTOMATIC LINE BLOCK SIGNALING

ALB-E and ALB-EL

The ALB-E and ALB-EL automatic line block systems based on the CBI-E and CBI-EL components are designed for sections, where train control is implemented using fixed and virtual block sections (including control without open line signals and on the basis of short track circuits).

Our automatic line block systems allow various options:

- three-aspect or four-aspect signaling;
- design both with and without block signals at the borders of the block sections (automatic cab signaling);
- control of the continuous automatic cab signaling (ATP) via a relay or digital interface;
- integration into the CBI-E system or operation as an independent train control system along with various types of electronic interlocking;
- equipment location both at the interlocking posts and in transportable modules.

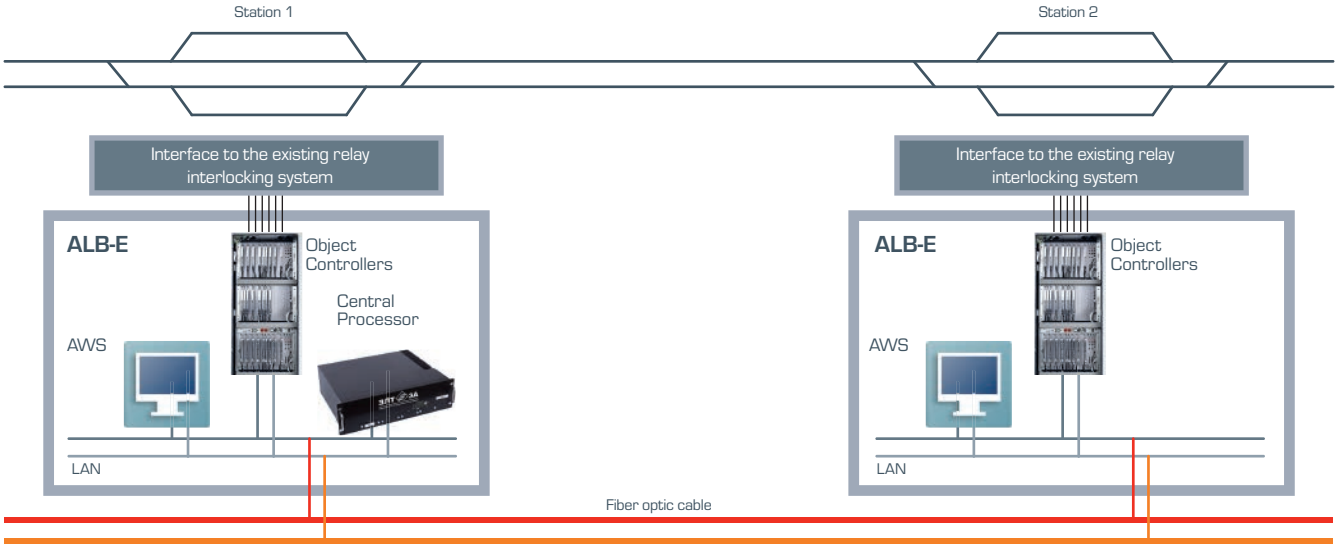
MAIN FUNCTIONS

- Logical control of the train movement along the track circuits of the open line.
- Encoding of the open line track circuits, including in the cab signaling mode with fixed block sections or moving block. Here, the ATP system operates as a separate signaling system.
- Change of train movement direction on the open line.
- Integration with loading gauge monitoring systems, bridge signaling, derail control devices, etc.
- Interface with the level crossing signaling, track maintenance staff notification system, hardware components set for malfunction diagnosing of rolling stocks running gear, etc.

ADVANTAGES

- Lower equipment volume compared to the relay system.
- High availability due to hardware redundancy.
- Reduce commissioning terms due to a high degree factory readiness and laboratory testing.
- Simple interface with the higher-level systems.
- Relay-free control of wayside equipment.
- Advanced diagnostics.

Design of ALB-E system (option as an independent system coupled with relay interlocking)



AUTOMATIC LOCOMOTIVE SIGNALING WITH VARIABLE BLOCK BOUNDARIES

ALSD-EL-P

The ALSD-EL-P system developed by the Signaling Division of GC NPS is applied as a separate signaling and communication mean on single- and multiple-track sections. ALSD-EL-P provides two-way train traffic along each track of the block guided by the light signals.

MAIN ADVANTAGES

- Lower hardware redundancy and implementation costs due to the integration of the train control function in the CBI-EL computer-based interlocking system.
- Higher reliability of the train traffic due to the ring topology of the station CBI links.
- Reducing lifecycle cost due to the lower amount of station and wayside equipment and to the advanced diagnostic tools.
- Lower operating costs for cables and wayside equipment.
- Minimum train delays due to the detection of false occupancy of protection track circuits.
- Higher throughput capacity due to transfer to the moving blocks, with potential adding of a radio-communication control in future.

Cabinets with the ALSD-EL-P hardware

AUTOMATIC CONTROL MODE FOR STATION MAIN TRACKS AND OPEN LINES

- With automatic control, train movement at a station is carried out using locomotive light signals (KLUB/BLOCK system's onboard safety units). At the same time, special white "X" indicators light up on wayside (entrance, route or exit) light signals.
- In the automated control mode, blocks and station tracks form one section. Within this section, train traffic is controlled by the ALSD-EL-P signals. The boundaries of the block sections are changed discretely to achieve the minimum permissible distance between trains.
- Uninterrupted train traffic is ensured by redundancy of the track circuits at hardware and software levels, as well as in the inter-processor communication networks.

COMPUTER-BASED AUTOMATIC LINE BLOCK

ALB-MSh

The Signaling Division of GC NPS proposes a computer-based automatic line block system ALB-MSh with audio frequency track circuits and centralized equipment layout.

The ALB-MSh system is intended for DC- or AC-fed single-, double- and multiple-track railway sections, sections with autonomous traction, sections with common power supply of coaches, locomotive and multiple unit turnaround sections with pulsed control of locomotive traction motors, as well as high speed lines. The system is designed for operation in moderate to cold climate.

MAIN FUNCTIONS OF ALB-MSH

- Automatic blocking and release of stop aspects of the intermediate light signals.
- Selection of the intermediate light signals' aspects.
- Monitoring of sequential occupation and leaving of the section track circuits.
- Change of train movement direction on the open line.
- Generation and transfer to the locomotive of data on the train situation via the channels of automatic cab signaling (ATP) and/or integrated ATP.
- Control and monitoring of the automatic level crossing signaling.
- Control of the traffic guide light signals (if any) with LED or bulb system.

HIGH AVAILABILITY AND MINIMUM TRAIN-TO-TRAIN INTERVALS

To improve the system availability and ensure its uninterrupted operation, all main modules of ALB-MSh are made redundant. There is provided a convenient Digital setting of the track circuit parameters from the FEU workstations. The mean time between failures of the system is not less than 50,000 hours. The system is protected against lightning and switching overvoltage.

ALB-MSh together with CBI-E provides the minimum train-to-train intervals on the Moscow Central Circle

ALB-MSh features application of moving block sections allowing minimization of the train-to-train intervals and providing a significantly higher railway capacity.

The ALB-MSh system is implemented on the Moscow Central Circle (MCC), Moscow Central Diameters (MCD), Trans-Siberian Railway and Baikal-Amur Mainline (Eastern polygon of JSC RZD), North Caucasus and South Eastern Railways.

LOCAL CONTROL AND SUPERVISORY SYSTEM

MultiRcos

The MultiRcos system is commonly used as an automated workstation of a station duty officer and field engineering unit, a local control center, a technical inspection point, as well as a centralized traffic control system along with the CBI-E, CBI-EL, RBI-E, RBI-EL interlocking systems and the radio-based train control system RBTC. The advanced functionality and adaptability of the MultiRcos system for a wide range of train control applications make it the most common local control and supervisory system (LCSS) in the 1520 gauge area. It is a cross-platform system and can run within a range of operating systems including the Russian RED OS and Windows.

Local control and supervisory system based on the MultiRcos system

SCALABILITY AND HIGH FLEXIBILITY

The MultiRcos system is based on the modular client/server principle, which allows scaling up the system from small stations to whole sections easily and effectively.

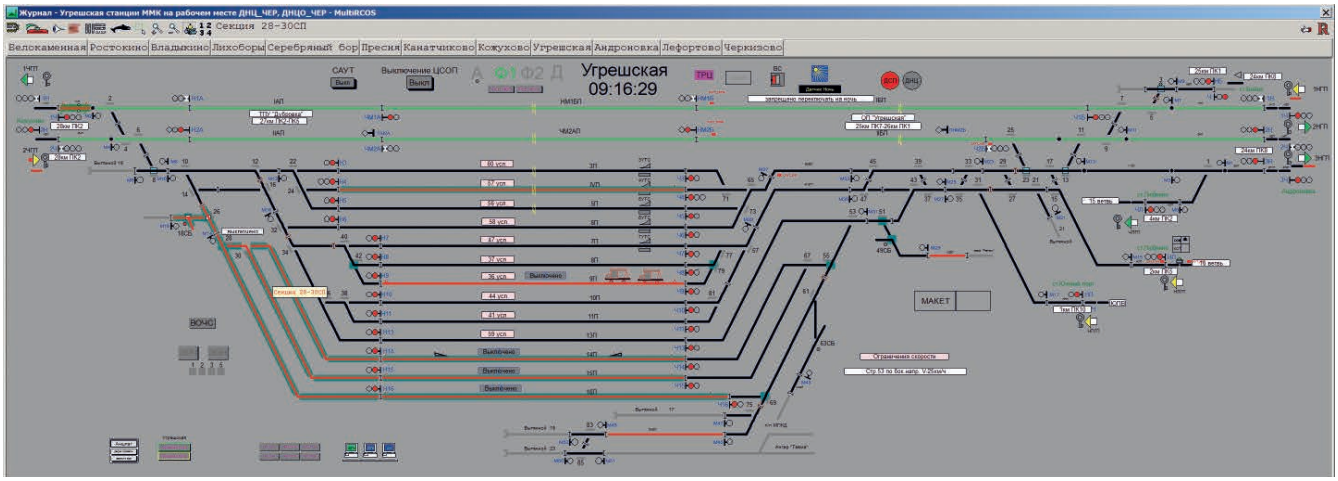
All the MultiRcos components are redundant, including the data transfer system and the workstations themselves. The MultiRcos system is equipped with an embedded self-diagnosis mechanism and allows obtaining diagnostic data from any external systems using both the standard SNMP and other data exchange protocols.

The MultiRcos LCSS system allows using national languages of any country in the world. Currently, Russian, English, Azerbaijani, Lithuanian, Latvian and Mongolian are available. A new language is added by modification of the system configuration files.

INTEGRATED OBJECT CONTROL

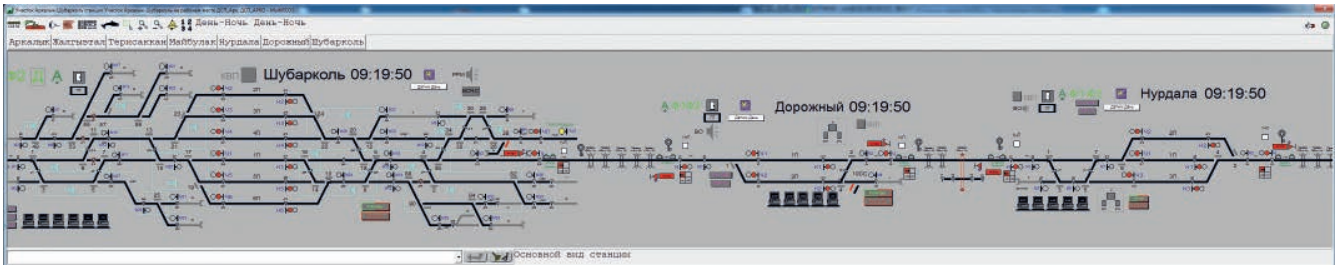
The developed concept of automatons (transfer of requests for command execution from one workstation of the system to another) allows joint

Mnemonic scheme of the Ugreshskaya station of the Moscow Central Ring (MCC) in the MultiRcos system



ADVANTAGES OF THE MultiRcos SYSTEM

- Technological scalability and hot standby: individual modules of the system can operate on geographically-distributed nodes in a hot standby mode.
- Ergonomic user interface to meet the requirements of any market/country.
- Dynamic multi-language support (switching the user interface languages without the system restart).
- Support for a distributed database, managed by the user (notices on the station mnemonic and a list of installed brake shoes).
- Support of automatons: sending requests for command execution from one automated workstation to another.
- The station database update in the background without interruption of the system operation.
- Logging of all events, as well as event replay, search and filter functionality.
- Support for fully dynamic objects (trains) with the ability to display them with indication of physical coordinates.
- The station database is stored in text format (XML), which allows using various available tools of change and source code version control for the development and testing.
- Interface with various train control, technical diagnostics and monitoring systems — ATP, Dialog CTC, Setun CTC, Trakt CTC, South CTC, automatic diagnostic complex for signals and interlocking, hardware/software package of centralized control, automated dispatch supervision system, line point data transmission system, command center data transmission system (CPDTS-6), Moscow metro CTC, etc. Each interface is made as an individual client module of the system and supports the hot standby mode.

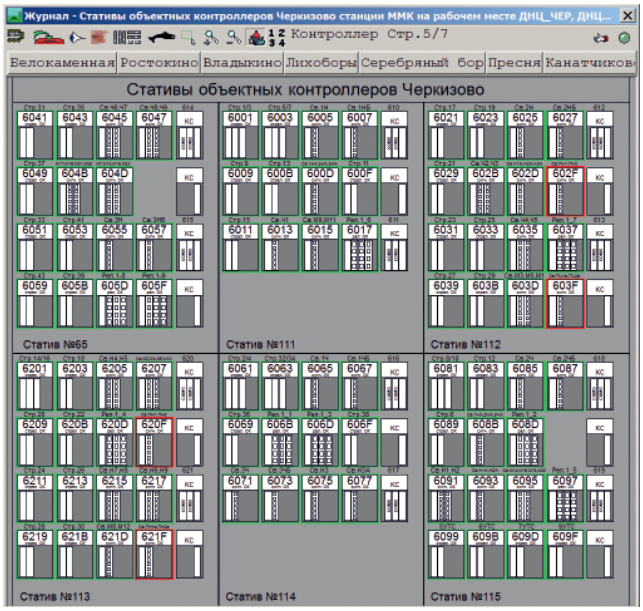


Mnemonic scheme of the Shubarkol — Nurdala section of the Kazakhstan railways

object control and integration with automated train control systems. The automatons created by the system operators are displayed on the station's mnemonic for the operator, who can either send the appropriate command, and confirm or reject its execution, or enable the automatic command execution mode.

MAIN FUNCTIONS

- Displaying the station's mnemonic.
- Preparation and entry of commands.
- Displaying diagnostic information of all subsystems.
- Running the protocol and database on the installed brake shoes and alarms.



Diagnostics of the object controller racks at the Cherkizovo station (Moscow Central Circle). Disabled object controllers are shown in red

CENTRALIZED TRAFFIC CONTROL SYSTEM

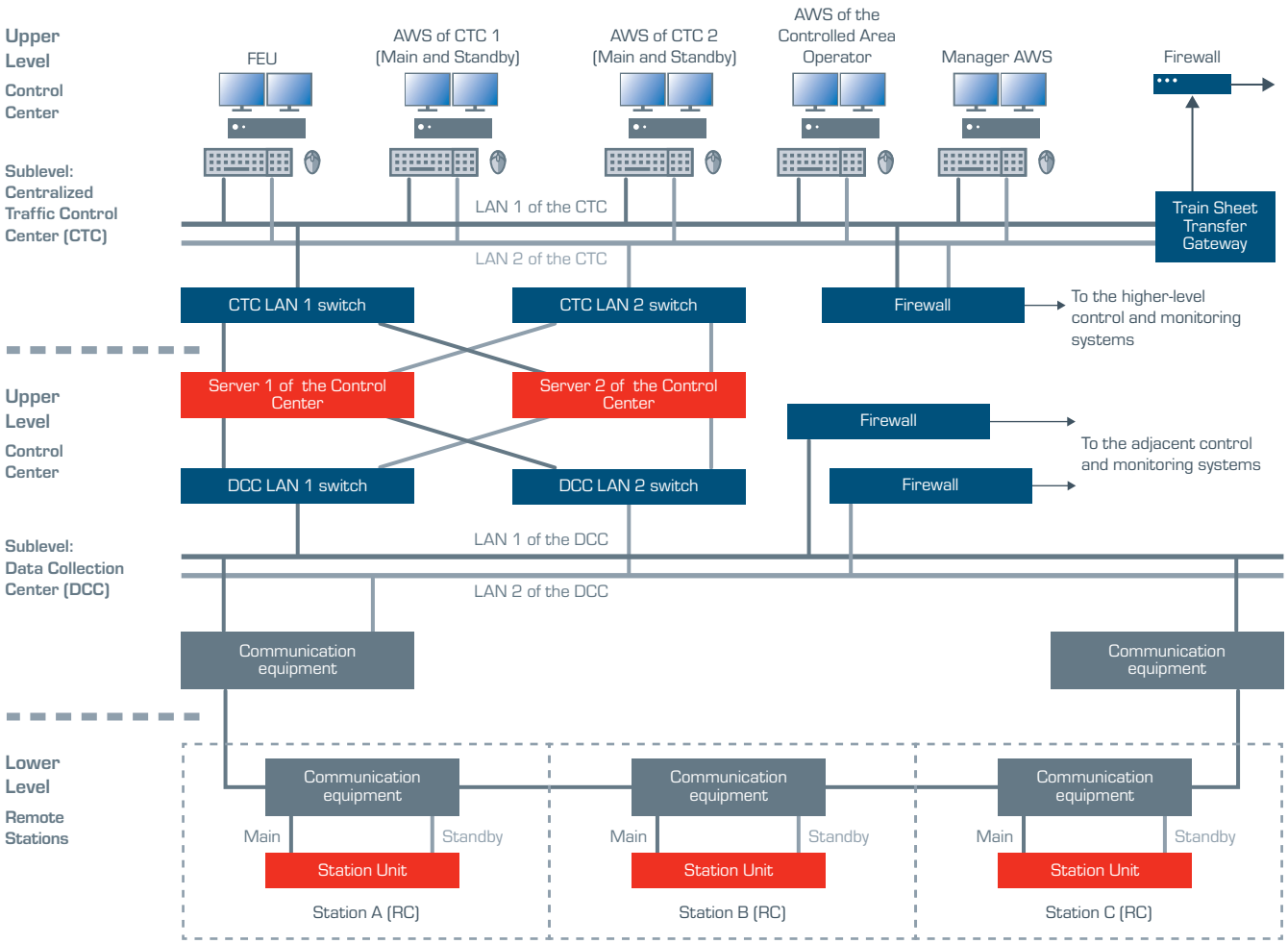
CTC-EL

The CTC-EL centralized traffic control system with Universal Station Units is a part of the Rail Control family of the Signaling Division of GC NPS and provides train control centralization for railway junctions, single- and multiple-track sections with any type of traction, high-speed mainlines, industrial and mass transit rail transport.

Features of the centralized traffic control system CTC-EL:

- support of any number of controlled and monitored objects without limitation;
- significant length of the controlled railway section—400 km or more;
- support of work with any types of block working system, including radio block systems with radio- based train control;
- scalability and open architecture—the list of functions and the number of dispatcher workstations can be increased without substantial costs if necessary;
- implementation of an operation planning functionality, train sheet generation, etc.;
- availability of the logic control algorithms;
- hardware based on a typical industrial devices.

Structure of the CTC-EL system



HIGH RELIABILITY AND AVAILABILITY

The CTC-EL system is based on a reliable unified equipment applied in other systems of the Signaling Division (CBI-EL, RBI-EL, etc.).

To achieve the maximum availability, it provides hot standby capability for all computer and telecommunication devices, as well as communication lines. This applies to equipment located both in the Centralized Traffic Control center and Universal Station Units.

HIGHER THROUGHPUT CAPACITY OF TRACK SECTIONS AND STATIONS

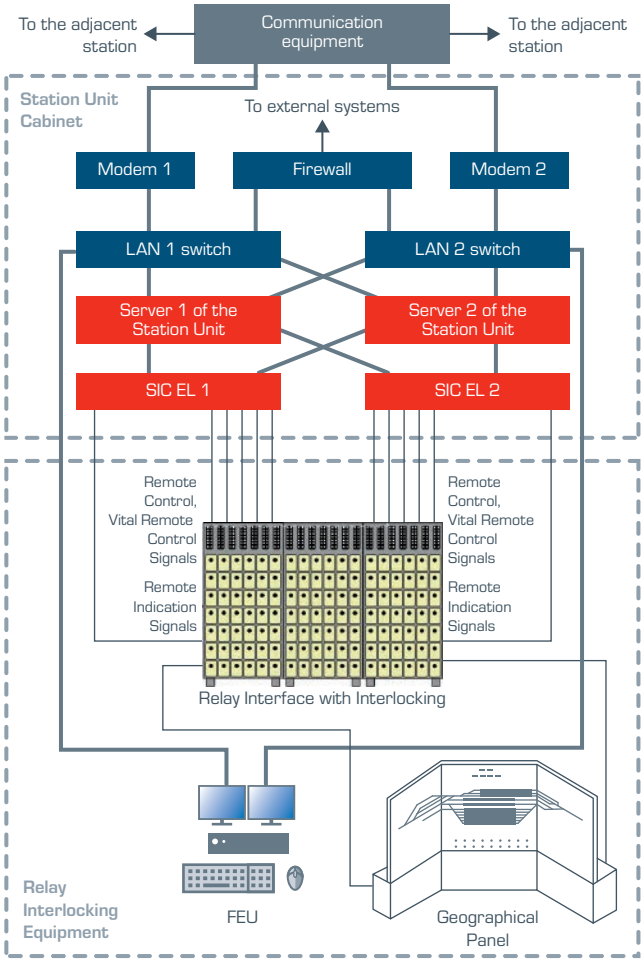
High centralization degree of the CTC-EL system along with its higher reliability and integration with the traffic management system RAIL TMS provides an optimal use of the railroad infrastructure and automation of the central traffic control with implementation of smart functions such as automatic dispatcher and automatic train operation.

UNIVERSAL STATION UNIT

The CTC-EL system provides several design options for a Universal Station Unit:

- built-in station unit within a CBI-EL or RBI-EL system (no need for additional hardware);
- universal integrated station unit for connection to the third-party CBI systems;
- Universal Station Unit for a relay interlocking system.

When connecting an Universal Station Unit to a relay interlocking system, the customer may choose either to keep the existing geographical panel, or to transform the relay system into a relay- and computer-based one, with replacement of the type group with the computer-based equipment. Implementation of the Universal Station Unit will allow switching to a computer-based interlocking in the future, while saving the previous investments.



SIC Safe Industrial Controller

Structure of a Universal Station Unit connected to a relay interlocking keeping the existing geographical panel

RAIL CONTROL—A FAMILY OF INNOVATIVE CENTRALIZED TRAFFIC CONTROL SYSTEMS

Along with CTC-EL, the Rail Control family includes the CTC-E centralized control system intended primarily for track sections equipped with CBI-E and RBI-E systems. The Rail Control family also includes the Dialog automated remote control system for metro trains.

The CTC-E system is deployed on several railway lines in Kazakhstan and on the Trans-Mongolian mainline, while the Dialog system is used by the Moscow and Tashkent Metros.

TRAFFIC MANAGEMENT SYSTEM

RAIL TMS

The traffic management system RAIL TMS of the Signaling Division of GC NPS allows train traffic optimization within the separate lines and regions of the railway network using such state-of-the-art technologies like neural networks and machine learning. RAIL TMS provides automation of the centralized traffic control.

Rail TMS is a integrated smart tool for planning, managing and optimizing rail traffic. The system's embedded virtual model of a railway section allows simulating various situations to find an optimal traffic option without interfering with the actual device operation. To resolve conflicts in the most effective way, it uses algorithms based on neural networks.

Modular architecture and scalability of RAIL TMS, as well as its standardized interfaces allow its connection to various external information systems providing the required data affecting the traffic. These features also allow gradual increase in the number of the handled conflicts. For these purposes, the system has two types of interactive user interfaces:

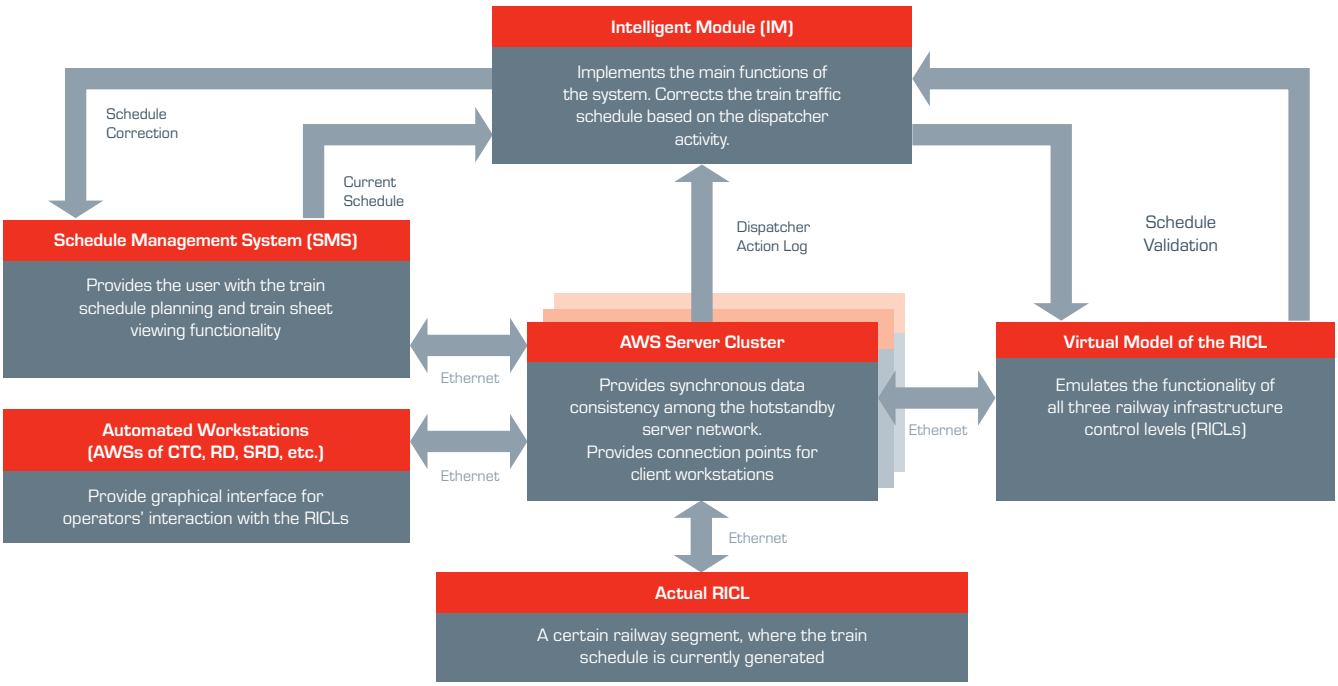
- automated workstations for operating personnel—train dispatcher (AWS of CTC), railway dispatcher (AWS of RD), senior railway dispatcher (AWS of SRD), etc.;
- automated workstations for schedule management.

FUNCTIONALITY

To predict the traffic situation and resolve conflicts, the RAIL TMS structure includes the Intelligent Module (IM). The schedule management system's built-in workstation provides the user with following capabilities:

- monitoring of the traffic compliance with the schedule;
- generating various reports;

Structural and functional diagram of RAIL TMS system



- receiving and recording the information required to form an array of data affecting conflicts;
- further processing of this data by the Intelligent Module.

RAIL TMS allows prompt modification of the train schedule depending on the identified conflicts, as well as predicting the train movement and potential conflicts taking into account all available data collected by the system.

The operating personnel's AWS can display the diagrams of dispatching circle, controlled railway section or the entire controlled region. It also allows generating the control commands for the infrastructure facilities in order to manage the train traffic.

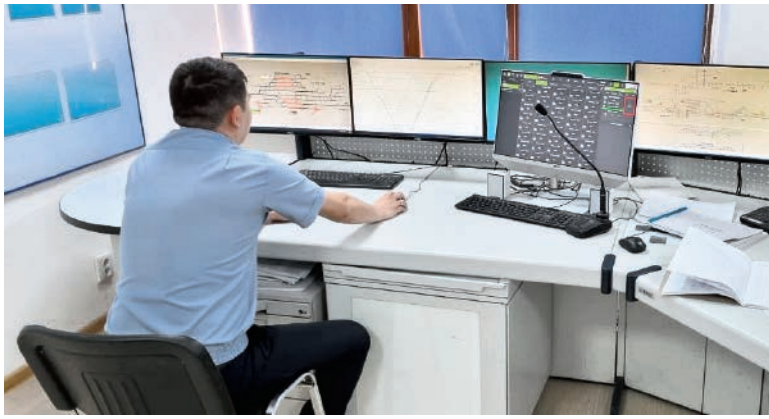
The operator's interaction with the signaling hardware (interlocking systems, train control systems, etc.) at the railway infrastructure control level (RICL) is implemented via the AWS server cluster. The virtual model of the RICL allows simulating various situations to find an optimal schedule options to avoid the potential conflicts in the train traffic.

INTELLIGENT MODULE

The Intelligent Module is a smart component of the RAIL TMS system and uses the artificial intelligence (AI) technologies to arrange management, optimization and planning of the train traffic.

When the user requests, it receives the current schedule and available restrictions. Using the AI technologies, Intelligent Module generates a corrected and optimized train schedule in few seconds. After approval by the user, this schedule is shared by the Schedule Management System to the operating personnel's AWS as a recent schedule version.

The neural network being the basis of AI can be trained on the basis of archived train sheet data or independently, focusing on the main optimization criterion—minimal deviations from a standard train schedule.



Operator's workstation of the RAIL TMS system

Functions of RAIL TMS

PREDICTIVE CONTROL

- Prediction of the train situation.
- Predictive identification of potential conflicts in the train traffic.
- Resolution of conflicts taking into account all priorities and restrictions.
- Automatic train control.
- Automatic route assignment.

PREDICTIVE PLANNING

- Schedule development and planning.
- Planning the schedule restrictions.
- Comprehensive planning of trains and capacities taking into account the railway station restrictions, traction energy parameters, locomotive depot situation, etc.
- Automatic search for conflict-free train paths taking into account priorities.
- Resolution of conflicts during the change and modification of a standard train schedule.

IMPLEMENTATION

Separate components of the RAIL TMS system (e.g. schedule management system) are successfully applied on the Trans-Mongolian mainline more than 1,100 km long, with 68 stations. In the beginning of 2022, specialists of the Signaling Division of GC NPS put the RAIL TMS system into trial operation in Kazakhstan, on the Zhetygen—Altynkol line, which length is 293 km.

RADIO-BASED TRAIN CONTROL SYSTEM

with moving blocks RBTC

The RBTC radio-based train control system, part of the RAIL Com family, implements the train control function and ensures safety at the stations and open lines through continuous data exchange between trains and the radio-block center, which receives data from the trains about their current location and transmits data on the acceptable traffic parameters to the onboard systems.

The Signaling Division of GC NPS has successfully introduced the radio-based train control system on railway lines with a total length of more than 3,000 km in Kazakhstan and Mongolia.

NEW FUNCTIONS OF RBTC

The RBTC implements several new functions compared to the traditional train control systems on open lines and stations:

- possible unconditional train stop upon a dispatcher's command;
- setting temporary speed limits by a dispatcher's command;
- control of run outside the limits of the station's operational area in the shunting mode;
- automatic setting of temporary speed limits in case of failure of the automatic level crossing protection system and train stops when the protecting signals are switched on;
- continuous real time monitoring of train traffic and train actual location.

COMPOSITION OF THE EQUIPMENT

The RBTC system consists of a stationary part and a set of onboard systems for traffic monitoring and control, radio-based data exchange, determination of the train location, measurement of speed and the distance traveled, calculation of the traffic parameters and braking speed curves, monitoring train integrity, etc.

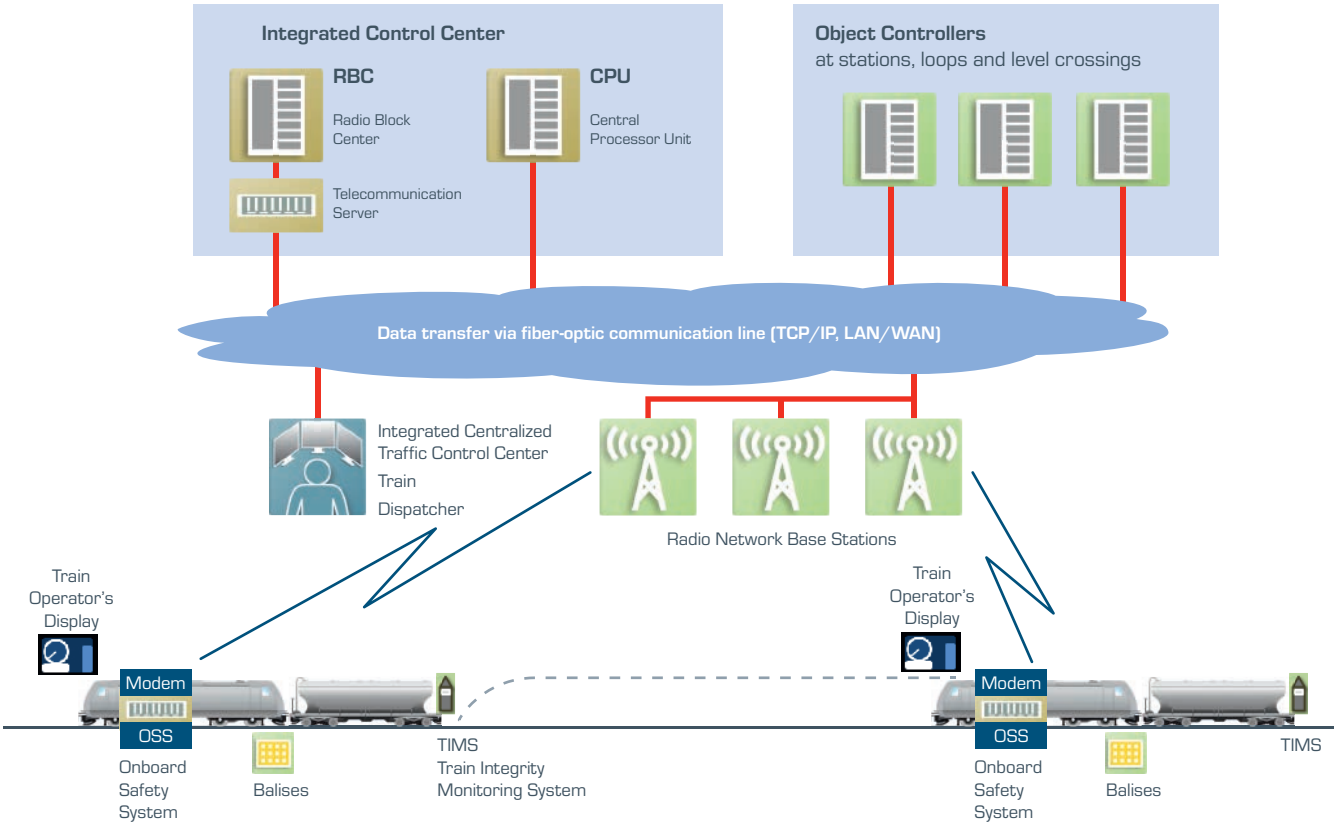
KEY FEATURES

The RBTC system is based on the moving blocks principle to increase the line capacity. The succession time is controlled based on the actual speed of each train and the train speed relative to another train.

Unlike the traditional automatic line block system, the moving block principle ensures control based on the tail coordinate of the train ahead, considering the minimum required protective section.

The RBTC system with moving blocks requires the minimum wayside equipment: track vacancy monitoring devices (signal track circuits or axle counters) at the stations, reference sensors (balises) on open lines, as well as radio communication base stations. However, fixed block sections, including virtual ones, can be implemented in the system.

The radio block center plays a key role in the RBTC system by controlling the current train situation and



Design of the radio-based traffic control system RBTC

issuing train traffic authorizations depending on the location and speed of the train ahead, as well as other parameters. It is closely integrated with the central processor of the CBI system and is built on the same hardware platform.

The system allows using radio communication networks of various standards that support digital data transmission (GSM-R, TETRA, etc.). The train position is determined using odometry devices integrated in the onboard safety system.

The onboard safety system includes a processor module, a speed and distance module, an interface with the onboard equipment, a receiver and antenna modules for reading data from the wayside reference sensors (balises), speed sensors and train operator's displays, as well as a radio modem, GPS and radio communication antenna. Onboard safety system interacts with the train integrity management system (TIMS).

Display of the RBTC onboard safety system on the train operator's console

The onboard safety system can be supplemented with a Specialized Transmission Module (STM) for the implementation of the continuous automatic cab signaling (ATP) functions when the locomotive is operating in sections with traditional automatic line block system.

ENHANCED CYBERSECURITY

KSPK-EL System

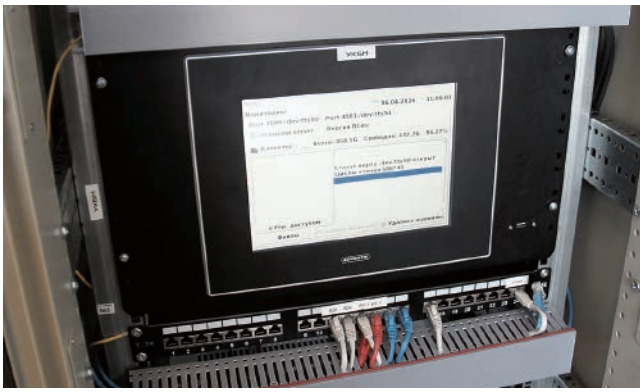
The KSPK-EL system, part of the RAIL Cyber family, provides a multi-level protection circuitry for train control systems. The KSPK-EL comprehensive cybersecurity system ensures secure external connections through the CyberSafemon cybersecurity monitoring device and the possibility to detect any external breaks in the data exchange system using the network traffic analysis sensor.

CYBERSECURITY MONITORING DEVICE CyberSafemon

The structure of the CyberSafemon includes a panel computer with a touch screen installed in a standard 19-inch cabinet, and modified RS-422 interface for one-way data reception. The front panel of the computer has a USB port for connecting external storage media.

The use of CyberSafemon significantly increases the information security level of the protected CBI, eliminating the need for connection of portable devices directly to the computer-based interlocking equipment for copying system logs.

CyberSafemon device

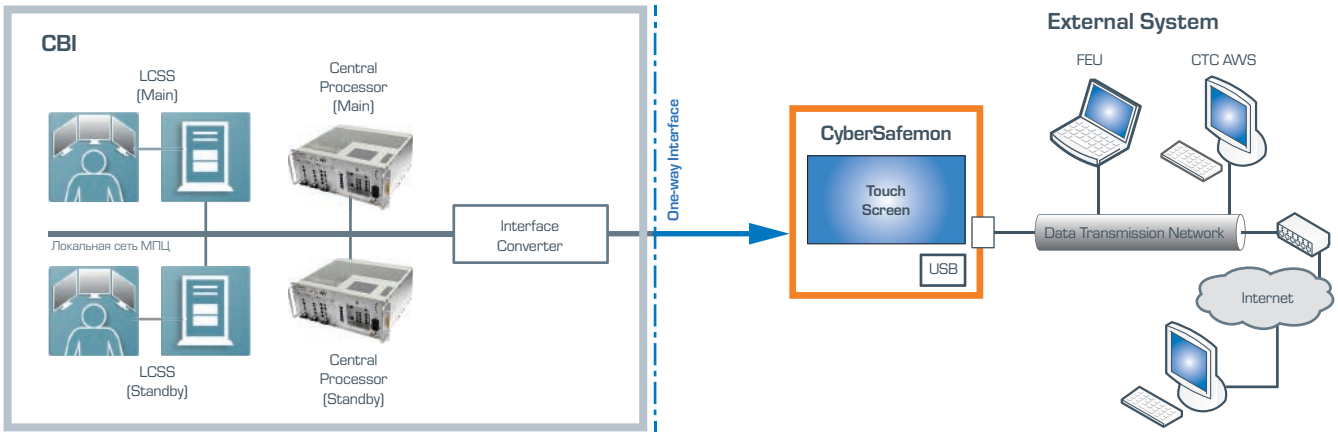


NETWORK TRAFFIC ANALYSIS SENSOR

The network traffic analysis sensor PT ISIM developed together with the Russian company Positive Technologies allows continuous monitoring and analysis of data packets transmitted via the local CBI network. All network traffic between the CBI components is mirrored to the server for analysis. The PT ISIM sensor verifies the correctness of the network communication between the system components and is able to detect cyber attacks on the components, including those using currently unknown vulnerabilities.

In case of a cyber attack is detected, the information of it is automatically transmitted to the field engineering unit (FEU) and to the persons responsible for threat responding.

Connection of external monitoring devices to the CBI through the CyberSafemon cybersecurity gateway



POWER SUPPLY UNIT WITH A DC BUS

PUSHP-E

The PUSHP-E power supply unit, part of the RAIL Power family, provides power supply of CBI systems and hybrid interlocking at different facilities, including those with unstable power quality and those having single-phase and three-phase feeders of electrical interlocking posts.

MODULAR DESIGN

The installation has a modular design and comprises several cabinets:

- cabinets of feeder input devices that are different for each feeder and diesel generator;
- cabinets of uninterruptible power supply input-rectifying installations with the power rating of up to 24 kW, with an automatic transfer switch (ATS) and uninterruptible power supply installations with a DC bus (48 V);
- a load distribution cabinet of backup power supply for computer-based and relay equipment;
- a battery cabinet and isolation transformer cabinet for galvanic isolation of various loads.

Specifications of PUSHP-E	
Climatic category	NF4 (for moderate and cold climate)
Nominal input voltage*	380/220 V $^{+25\%}_{-23\%}$
Frequency of input voltage	49 – 51 Hz
Nominal output voltage	220/380 V ±5%
Frequency of output voltage	50 Hz ±0,1 Hz
Output voltage THD	Less than 2%
Power per cabinet of uninterruptible power supply input-rectifying installation**	From 12 to 24 kVA
Warranty (from the commissioning date)	3 years

* If there are mains deviations from the required parameters, the power is supplied from a maintenance-free battery unit.

*If more power is required, several cabinets for uninterruptible power supply input-rectifying installations and battery cabinets are used.

PUSHP-E Power Supply Unit

POWER SUPPLY UNIT

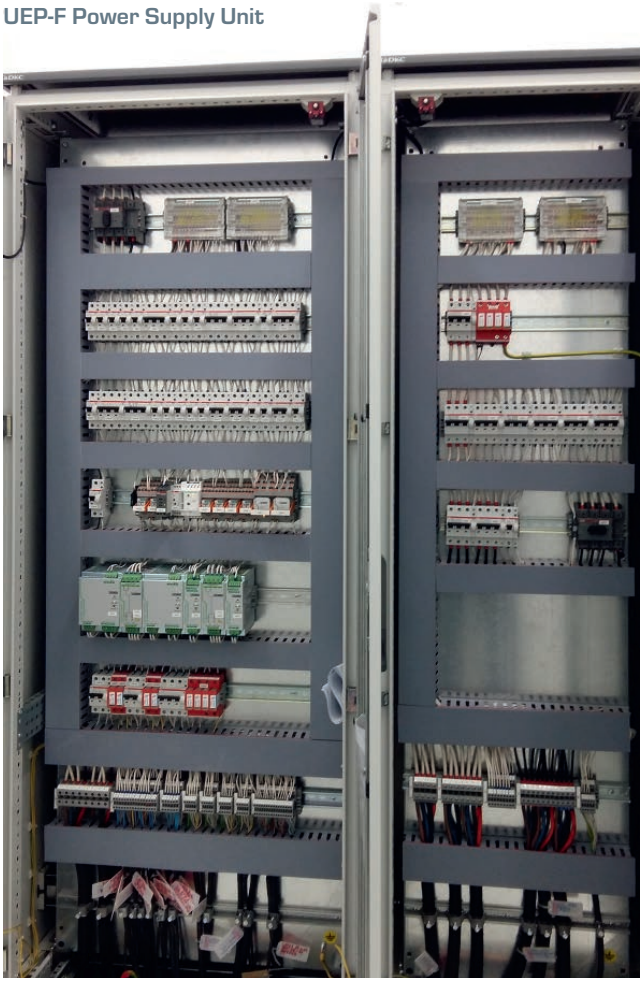
UEP-F

The UEP-F installation, part of the RAIL Power family, is designed for a guaranteed uninterruptible power supply for interlocking and block posts.

It comprises:

- input distribution boards according to the number of feeders;
- an automatic standby initiation board;
- switchgear assemblies, including those supplying the automatic workstations of control posts with the function of remote emergency manual shutdown of the power supply unit;
- uninterruptible power supply devices battery cabinets.

UEP-F Power Supply Unit



Specifications of UEP-F	
Climatic category	NF4 (for moderate and cold climate)
Nominal input voltage*	380/220 V
Frequency of input voltage	49 – 51 Hz
Nominal output voltage	24**/220/380 V
Frequency of output voltage	50 Hz ±0,1 Hz
Output voltage THD	Less than 2%
Power of a cabinet of uninterruptible power supply input-rectifying installation***	From 10 to 60 kVA
Warranty (from the commissioning date)	3 years

*If there are mains deviations from the required parameters, the power is supplied from a maintenance-free battery unit.

** Optionally.

*** If more power is required, several cabinets for uninterruptible power supply input-rectifying installations and battery cabinets are used.

FLEXIBLE CONFIGURATION

The UEP-F has a wide range of modifications depending on the number of feeders, power load and operating conditions. To electrify computer-based systems the UEP-F system is additionally equipped with redundant power supply cabinets (24 V) and can be supplied in a modification that also presupposes redundancy of uninterruptible power supply of critical load.

Dimensions and design of the devices allow locating the power supply unit in standard transportable container-type modules that are used on railways for the deployment of modular facilities of relay interlocking and tonal circuits automatic block posts.

The UEP-F is a maintenance-free system and is capable of operating in automatic mode. The installation is equipped with the required overload, overvoltage and short-circuit protection devices. The system provides control of device operability, input and output voltage parameters, distributed energy measurements with an option of transmitting the data to an automated workplace of duty personnel or to a remote monitoring system.

POWER SUPPLY UNIT

UEP-U

The UEP-U power supply unit lineup, part of the RAIL Power family, includes three- phase power supplies for computer-based, hybrid and relay interlocking, automatic line block and hump switching systems, as well as single-phase power supplies for automatic level crossing signaling, small relay interlocking systems, temporary interlocking posts and automatic line block systems.

All power supply units are equipped with standard cabinets for the input of three- and single-phase power feeders, regulation, distribution and uninterruptible AC and DC power supply at different voltage levels.

The UEP-U-M power supply unit is intended for computer-based interlocking systems and provides the following functions:

- connection of cables from the two external power sources — a three-phase AC source (main and standby feeders) and a diesel genset feeder;
- uninterruptible power supply of loads connected to the UPS system during the specified time interval, including the periods of transfer between the external power sources and their downtime;
- continuous monitoring of the external power sources with regard to their overvoltages, undervoltages (at any phase), phase sequence, phase loss, AC frequency;
- monitoring of tripping of the overvoltage protections and circuit breakers, control of the DC source operation, remote indication of the UPS failures by the centralized control system;
- operation in the modes with a priority or equal feeder duty.

WIDE DIAGNOSTIC CAPABILITIES

UEP-U-M includes an upgraded distribution panel PRM-E-08 for power supply of the ALB-MSh system. Using its backup battery unit, each PRM-E-08 panel can provide an uninterruptible power supply of loads with a power up to 25 kW.

Installation of the UEP-U-M power supply unit

Specifications of UEP-U-M	
Input mains	Three-phase
Feeder cable cross-section	Up to 25 mm^2
Rated current	Up to 80 A
Rated current at 24 V	Up to 80 A
Power supply of open line light signals	Yes
Power supply of station light signals	Yes
Power supply of electric point motors	DC and AC
Duty mode	Continuous 24/7
Warranty (from the commissioning date)	3 years
Service life	25 years

The PRM-E-08 panel has an integrated diagnostic system displaying the condition of all panel devices, power quality parameters and alarm event log on its screen. The event history of the distribution panel and the mnemonic of the installation power supply can be displayed as well.

MODULAR COMBINED POWER SUPPLY UNIT

for Metro

Since August 2018, the Signaling Division of GC NPS deploys the MSPU modular combined power supply units from the RAIL Power family on the Moscow and Tashkent metro stations. These units provide a reliable and uninterruptible power supply for computer-based and relay train control equipment. The modular design of these units makes their configuring for specific implementation facilities much easier.

ADVANTAGES OF MSPU

- Automatic and manual load switching between feeders during their downtime or power quality deviations (over-/undervoltage, wrong phase sequence or phase loss) on the working feeder.
- Uninterruptible power supply of the train control equipment.
- Galvanic isolation between the power sources and the signaling train control equipment loads.
- Protection against lightning and switching overvoltages at the input circuits from the external AC sources.
- Automatic monitoring of the insulation resistance drop in the power circuits of signaling train control equipment loads.
- Compatibility with any grounding system.
- Operation in the equal feeder duty mode or in the mode with one priority feeder (1st or 2nd).

MSPU cabinets

- Measurement of operation parameters by the panel-mounted instruments (voltages and currents of feeder lines, voltage of load power lines and current of battery circuits).
- Emergency tripping and disconnection of the power feeders and battery unit from the STCE loads.
- Light alarm and status indication for the feeders, units, circuit breakers, insulation resistance drop in the monitored circuits.
- Remote alarm and status indication for the MSPU equipment using dry contacts or Ethernet interface.
- Real-time indication and archiving of status information for the MSPU equipment via the MSPU and higher-level automated workstations.

DESIGN OPTIONS

The Signaling Division of GC NPS provides two types of modular combined power supply units for metros:

- MSPU-20-03-M Ets for relay STCE equipment with a power rating up to 20 kVA and
- MSPU-40-02-MD for computer-based STCE equipment with a power rating up to 40 kVA.

The latter has several versions for different voltages of the input three-phase AC source — 3×220 V and 3×380 V.

The MSPU units' mean time between failures is at least 40,000 hours, while their assigned useful life is at least 25 years. The battery power time for computer-based or relay STCE equipment is at least 1 hour.

The modular combined power supply units are implemented at 74 stations of Moscow and Tashkent Metro. The MSPU units show the highest reliability, providing power supply and protection of computer-based and relay STCE equipment.

SURGE OVERVOLTAGE PROTECTION

systems

The Signaling Division of GC NPS has been actively implementing various solutions aimed at the protection of railway signaling systems. Surge overvoltage protection systems of the RAIL Light family have been successfully certified and proved to be very efficient at multiple facilities on the railways in Russia and other countries.

POWERFUL AND RELIABLE PROTECTION

Surge and switching overvoltage protection of computer-based signaling systems is extremely important for any railway sections because it allows significantly minimizing and even avoiding the failures caused by lightning, power switching (including such events in electric traction networks) and violation of work procedures.

Surge overvoltage protection systems of the RAIL Light family consists of general-purpose input-protection devices that are located at the point of wayside cable input into interlocking post facilities and are joined together with a potential equation subsystem, protective grounding and devices that control the operation of protection equipment.

Our Surge overvoltage protection systems provide high levels of protection. The key features of the systems lie in the design of input- protective devices that differ from each other in:

- the overall dimensions and the modification of equipment racks;
- the number of protected circuits;
- internal arrangement;
- modification of major components;
- mounting and maintenance principles.

The surge overvoltage protection systems use modern, effective, reliable and easy-to-use protection devices.

The surge overvoltage and input protection device

They have a modular design that makes a replacement possible in the event of the system actuation. The subsystem that controls the actuation of protective devices transmits the information to automated workplaces of the duty personnel.

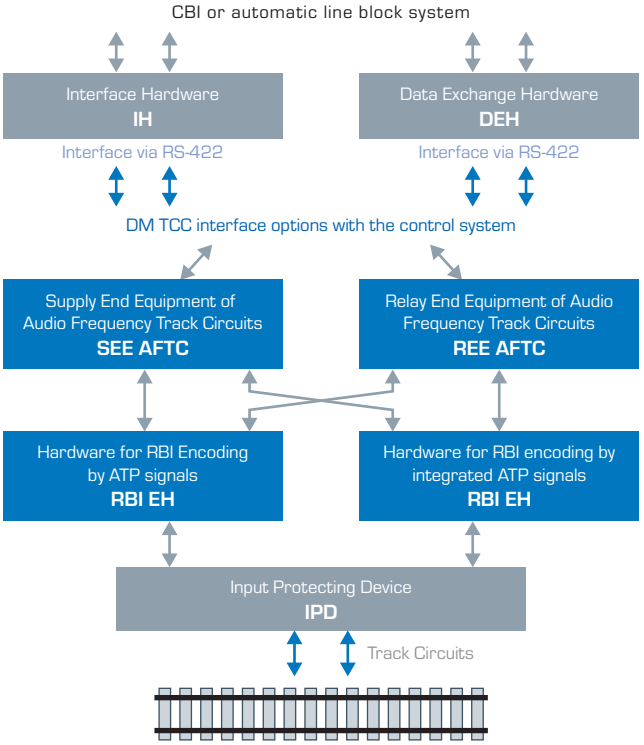
AN EFFECTIVE SURGE PROTECTION DEVICES TESTING

To improve operational efficiency and to make scheduled maintenance and testing of the surge protection devices easier, the surge overvoltage protection system includes the SPD test-signal generator. It provides testing of all SPD types and automatically records the test results. The range of its testing voltage is from 0 to 2,500 V (to test for static breakdown voltage). The generator has an additional option — generation of 1.2/50 ms test impulse up to 3 kV (to test for dynamic breakdown voltage). The Proryv SPD test-signal generator complies with the standard requirements of GOST R 8.536-2009 and is certified for compliance with the Technical Regulations of Customs Union CU TR 004/2011 and CU TR 020/2011.

DIGITAL TRACK CIRCUIT MONITORING MODULES

DM TCC and DM TCC-M

The digital track circuit monitoring modules DM TCC and DM TCC-M (modification for metro), parts of the RAIL Track family, are designed for station and open line signaling systems with audio frequency track circuits and centralized equipment layout. They are widely used on the railways in Russia and other countries within the 1520 gauge area. The DM TCC-M system with encoding the audio frequency track circuits by the ARS frequencies has been successfully implemented on two lines of the Moscow Metro.



Structure and composition of the digital track circuit monitoring module equipment for DM TCC

WIDE FUNCTIONAL FEATURES

Along with basic functions, for example, the track section vacancy and the track circuit integrity monitoring, data transfer of the track circuit state to higher-level systems via a digital or relay interface, generating and transmitting continuous automatic cab signaling (ATP) and/or integrated ATP signals to the track circuit, the digital track circuit monitoring module performs the following functions:

- automatic self-diagnosis with status data transfer to the diagnostic center;
- comprehensive protection of the equipment against lightning and switching overvoltages with registration of the number of trips;
- cable core jumpering;
- power supply distribution for audio frequency track circuits by power beams.

ADVANTAGES OF DM TCC AND DM TCC-M

- Enhanced reliability ensured by electronic equipment redundancy, duplication of communication channels and automatic switching to a standby channel.
- Enhanced security ensured by a dual-processor schematic-based design of devices with strong connections.
- Elimination of coding errors in short track circuits due to synchronization of generated ATP signals.
- Resistance to lightning and switching overvoltages.
- Protection against supply voltage dips and interruptions.
- Reduced number of relays due to digital linking to the control systems via the RS-422 or Ethernet interfaces.
- High level factory readiness.

DIGITAL TRACK CIRCUIT MONITORING MODULE WITH AUTOMATIC SIGNAL LEVEL CONTROL

DM TCC-AR

The DM TCC-AR digital track circuit monitoring module with automatic signal level control, part of the RAIL Track family, is a complete track circuit monitoring and coding subsystem with the data reception and transmission via a digital and/or relay interface. The DM TCC-AR module is applied in the existing and newly installed computer-based interlocking systems with audio frequency track circuits and centralized equipment layout.

MAIN FUNCTIONS

- Monitoring the track circuit vacancy and occupancy and the rail line integrity with transfer of the corresponding data to the CBI.
- Generation and transmission of continuous automatic cab signaling (ATP) and integrated ATP signals to the track circuits.
- Comprehensive protection of the track circuit and coding equipment against lightning and switching overvoltages.
- Automatic voltage adjustment at the track generator output, when voltage at the track receiver input is close to the permissible minimum and maximum limits.
- Automatic diagnostics of the module components with recording failures and the pre-failure condition dats of the audio frequency track circuit equipment.

ADVANTAGES OF THE DM TCC-AR MODULE

- High availability of the monitoring and encoding hardware ensured by redundancy of all components and duplication of communication channels.
- Increased resistance to lightning and switching overvoltages
- High noise immunity of the audio frequency track circuit equipment ensured by the advanced methods of digital signal processing.

Digital track circuit monitoring module DM TCC-AR

- Elimination of possible human errors due to automatic signal control in the audio frequency track circuits.
- Ability to select the track circuit encoding frequency (25, 50 or 75 Hz).
- Reduced cost and scope of installation work due to application of the high factory readiness technology.

COMPUTER-BASED AXLE COUNTER

system

The computer-based axle counter system is a part of the RAIL Track family and is designed to determine vacancy of the track section of any complexity and configuration at the stations and open lines by the axle counting method using wayside wheel sensors and counters. The system is based on the CBI control computer and has a two-channel design and diversified software.

The computer-based axle counter system is developed according to the recent safety requirements. It is a rugged system, resistant to the impacts of industrial and mainline railway environments. It features a lighting protection system and can operate even in the Far North conditions.

APPLICATION OPTIONS

- Determination of the track section vacancy at the stations and open lines.
- Interaction with any signaling and interlocking system.
- Placement of wheel track sensors on rails of any type in the sections with both electric (of any current) and autonomous traction.
- Equipping the sections where track circuits are too expensive or technically unavailable.

FUNCTIONS AND PRINCIPLE OF OPERATION

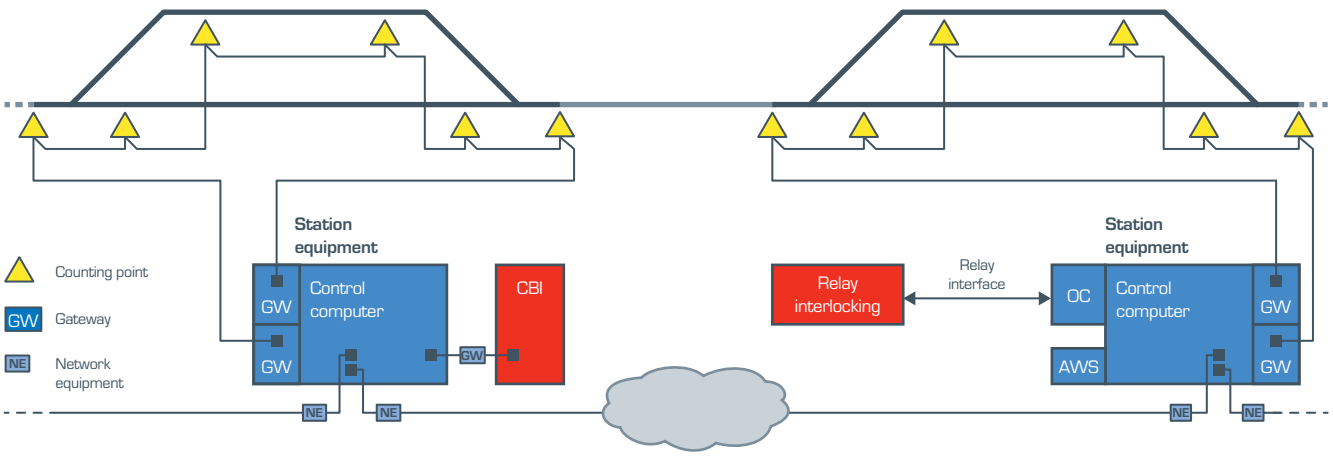
The computer-based axle counter system determines the occupancy/vacancy of the sections bounded by the wayside wheel sensors. Signals from the wayside sensors come to the wayside counters that generate data on the number of passed train axles and transfer this data for further processing in the post computing devices.

Data on the number of axles that entered and left the corresponding section allows the system to determine the free or occupied state of the section, and then transmit this information to the signaling system via a relay or electronic interface.

The system allow resetting the signals of false section occupancy, as well as individual or group resetting of the wayside counters.

The advanced self-diagnosis and event logging functionality allow generating real-time status notifications for the system components and controlled sections.

Design of the computer-based axle counter system



SYSTEM ARCHITECTURE

Flexible architecture of the computer-based axle counter system provides interaction with the signaling, interlocking and centralized control systems of various types and with various elemental base; it is easily configured for a specific project.

The wayside equipment of the computer-based axle counter system is a set of counting points including wayside sensors and counters. The counting points are included into a two-channel communication loops connected to the system's gateways. For the communication loops longer than 1 km, the wayside repeaters are used.

Connection between the redundant gateways and communication loops provides an uninterrupted monitoring the section vacancy and occupancy even if a cable is broken down or one of the wayside repeaters fails.

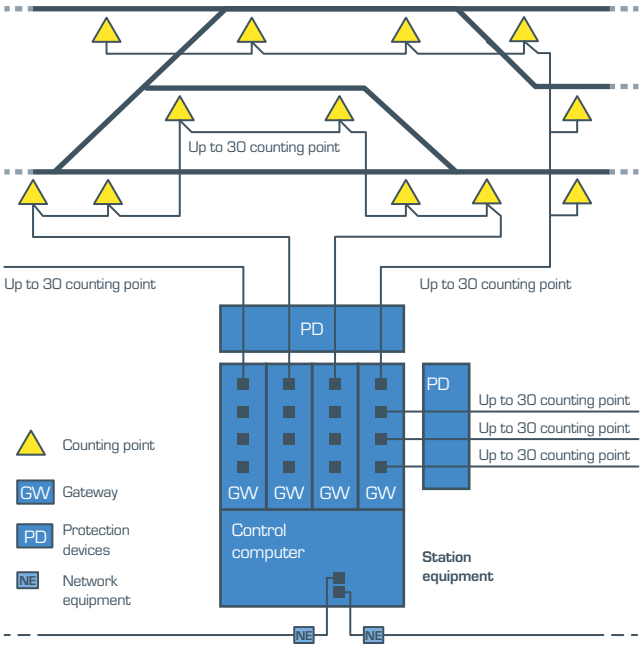
The data from the wayside devices is processed and the condition of the sections is determined by a control computer using two channels and 2oo2 system.

The secure computing channels use processors with different architecture, different operating systems and diversified application software. If necessary, the system can be equipped with two control computers, one of which is in hot standby.

The computer-based axle counter system and the computer-based interlocking are interconnected via a digital interface.

Reset commands for the false section status and wayside devices can come from the LCSS and FEU workstations.

At the stations with relay interlocking, the computer-based axle counter system is complemented with the RUVIO relay object controllers to arrange an interface with the interlocking. It also has an automated workstation to output the advanced diagnostics data and to operate the wayside and station equipment.



Block diagram of the computer-based axle counter system

SPECIFICATIONS

- Simultaneous control of up to 1,024 counting points.
- Up to 120 counting points per a gateway or pair of redundant gateways.
- Up to 32 gateways for interface with the wayside equipment.
- Up to 30 counting points per a communication loop.
- The length of a communication loop with wayside counters (without additional repeaters) up to 1,000 m.

DEEP INTEGRATION WITH DIVISION'S CBI

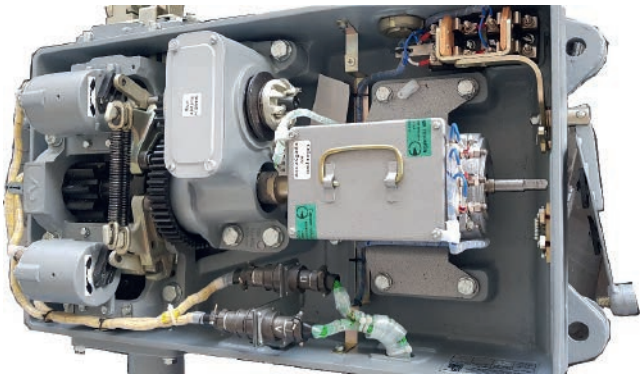
If an axle counter system is included into the Division's computer-based interlocking systems (CBI-E, CBI-EL and CBI-SM), there is no need to use a separate computer-based axle counter control computer. The software application of the axle counter system can be deployed on the CBI central processor. This reduces the amount of hardware, ensures space savings and enhances the cost-effectiveness of such solution for the customer.

CANTILEVER NONTRAILABLE ELECTRIC POINT MACHINES

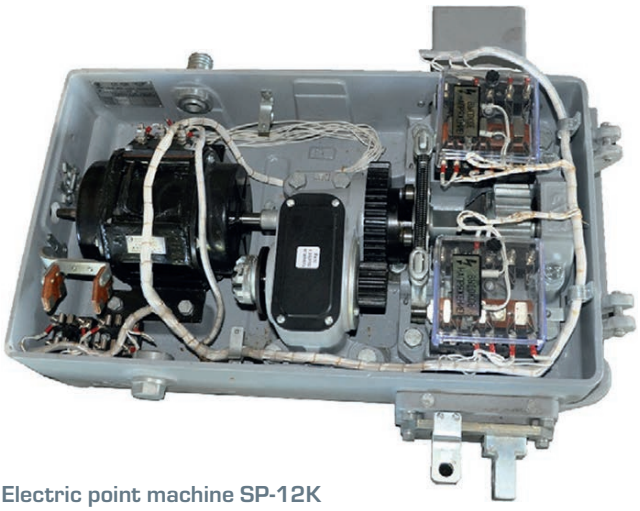
for mainlines, higher-speed lines and industrial transport

The Signaling Division of GC NPS supplies a family of electric point machines RAIL Switch including the range of cantilever electric point machines (SP-6MG, SPG, etc.) featuring an improved design, high reliability and a long service life.

The Division also manufacturers the SP-12N and SP-12K electric point machines for sections with train speed of up to 200 km/h. The cantilever electric point machines are widely used by the railways and well-proven in the operation.



Electric point machine SP-6MG



Electric point machine SP-12K

ELECTRIC POINT MACHINES FOR MAINLINES AND INDUSTRIAL TRANSPORT

The nontrailable electric point machines SP-6MG, SPG and other with internal locking apply an improved automatic switch design based on magnet controlled sealed sensors.

Reed sensors are not subject to burning and are free of the disadvantages of a knife blade contact group of auto-switches, since they are not affected by climatic factors, mechanical stresses and potential errors of the operating personnel. The electric point machines SP-6MG, SPG and other are also available in tropical design.

ELECTRIC POINT MACHINE FOR HIGHER-SPEED LINES

The SP-12N, SP-12K nontrailable electric point machines with valve leaf travel of 220 mm are designed for switching in intermittent service mode, short-circuiting and continuous control of the turnout position with a continuous tread surface, including point trailing monitoring. The SP-12N, SP-12K electric point machines are designed for operation on higher-speed lines with train speed up to 200 km/h.

SP-12N (SP-12K) is installed on a crosspiece complete with an external locker and ensures the moving crosspiece core locking to the counter rail in extreme positions.

HARDWARE-SOFTWARE COMPLEX OF HIGH-SPEED SWITCH CONTROL

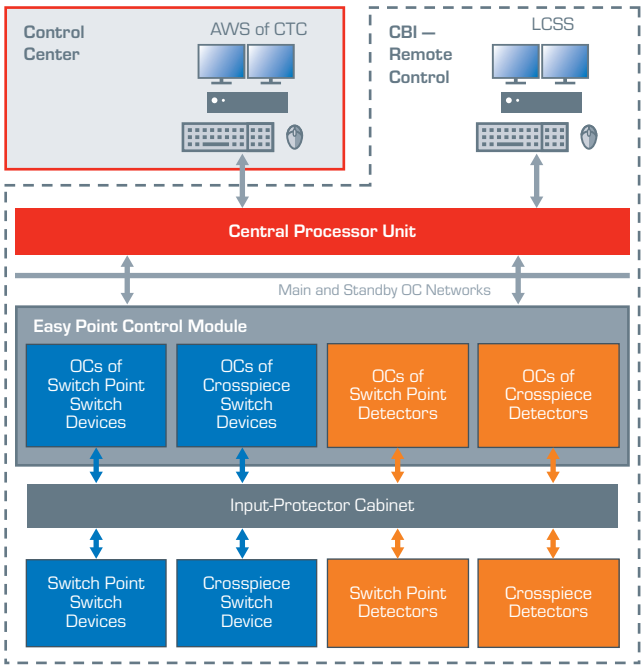
APK UPS

As a part of the project intended to develop a Russian train control system for high-speed mainlines, the Signaling Division of GC NPS has designed a Hardware-Software Complex of high-speed switch control APK UPS.

The package is intended for control and position monitoring of points with a frog number equal to 1/25 designed for train speeds up to 400 km/h when passing straight and up to 120 km/h when diverging to a side track.

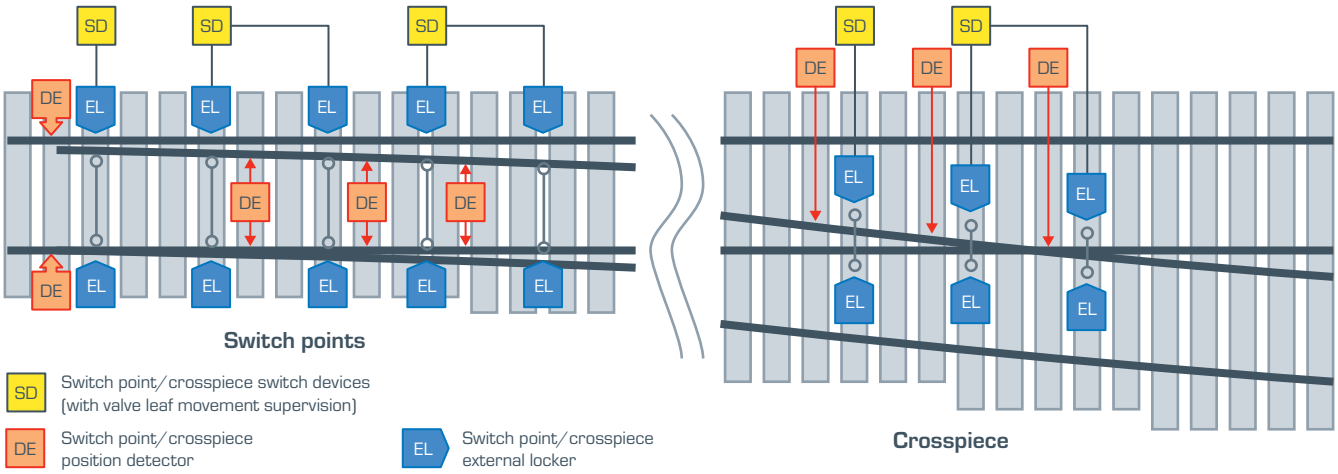
The APK UPS software runs as a part of the CBI central processing unit's basic software. It provides control, monitoring and generation of diagnostic data for an object controller system working with a set of switch devices and easy point's switch point & crosspiece closing detectors. To avoid power source overloading by inrush currents at the beginning of the point operation, the turn-on commands for the easy point's switch devices are sent sequentially, with a permissible delay.

At the level of executive devices, the APK UPS package includes the object controllers of switch point and crosspiece switch devices, switch point and crosspiece closing detectors, the object controllers' local network, as well as their power supply equipment.



Block diagram of the APK UPS

Diagram of a R65 type point with a frog number of 1/25 equipped with the APK UPS hardware



AUTOMATIC LEVEL CROSSING PROTECTION SYSTEMS

MAPS-E and MAPS-EL

The RAIL Cross family of level crossing protection equipment includes the MAPS-E system and its modification MAPS-EL based on a Russian hardware platform, which provide safety on level crossings of single-track and multiple-track railway sections with any type of autonomous or electric traction. They can work in automatic control mode or with manual control by a level crossing attendant.

FLEXIBLE ARCHITECTURE

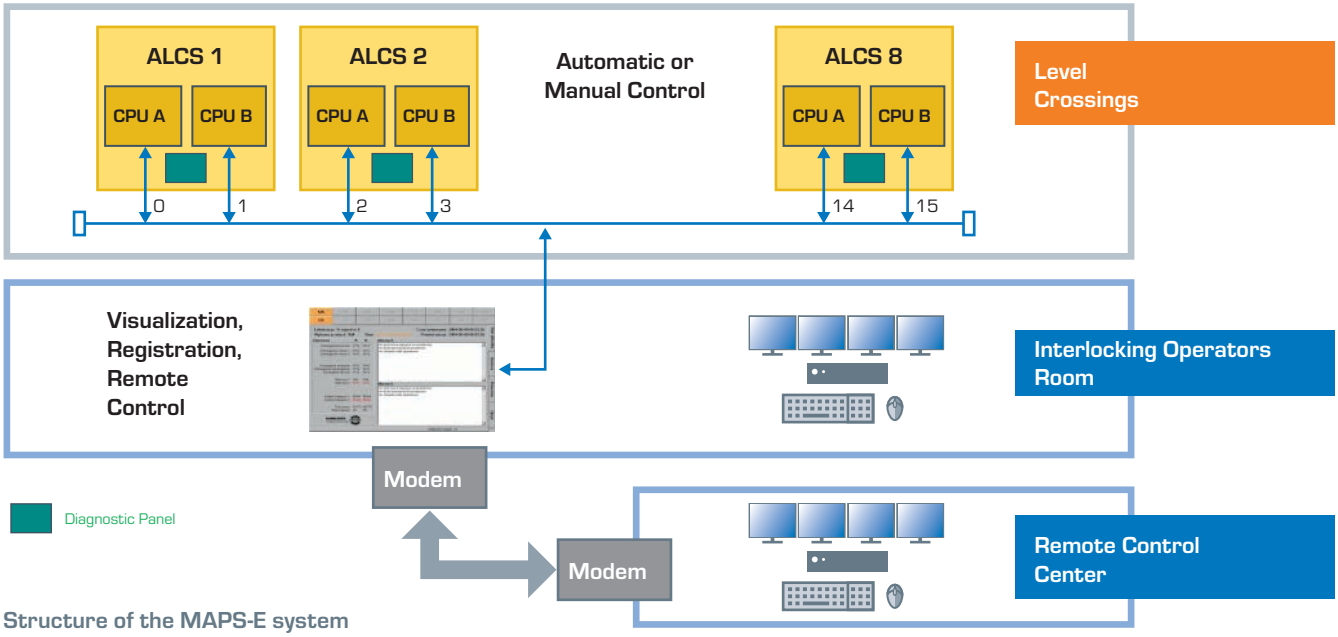
The MAPS-E and MAPS-EL systems have a flexible architecture and can interact with signaling systems of various types and generations. They can be configured for a particular project at the factory, but allow adjustment on-site if the operating environment has changed.

Level crossing signals, gate machines, axle counters, protecting signals and other equipment, including already operating equipment, can be added to both systems. The power supply subsystem includes an overvoltage protection and provides a 24-hour fully autonomous operation of the automatic level crossing signaling. The remote monitoring and control subsystem allows simultaneous control of up to 8 level crossings equipped with MAPS-E or MAPS- EL and can be easily integrated into the centralized traffic control and station interlocking systems.

HIGH LEVEL OF SAFETY AND RELIABILITY

The MAPS-E (MAPS-EL) system is designed as a functionally safe computer-based arrangement, with a two-channel topology (including power supply), with a diversified software and embedded self-diagnostics subsystem. The MAPS-E system complies with the European (CENELEC SIL4) and Russian safety requirements.

The MAPS-E and MAPS-EL level crossing protection systems are designed for the most harsh environments and various climatic zones, including the Far North conditions. The MAPS-E system can be equipped with radars to control the level crossing area under all weather conditions.



Structure of the MAPS-E system

AUTOMATIC LEVEL CROSSING PROTECTION

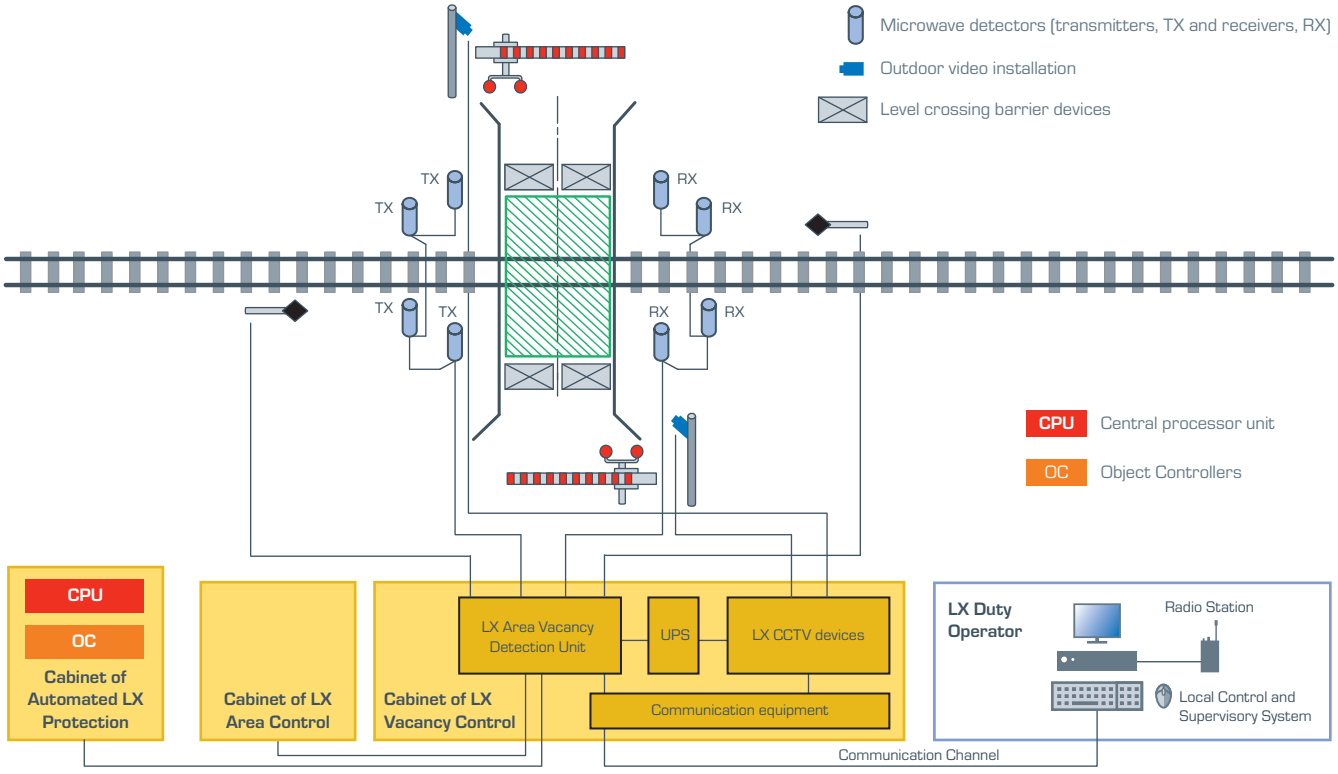
MAPS based on the Platform 2.0

The MAPS system based on the Platform 2.0 is the recent innovative solution by the Signaling Division of GC NPS. It is designed using Russia- made components. The standard configuration of the Platform 2.0 based system fully implements the functionality of an automatic level crossing protection. Different options allow significantly extending the functionality of the system by installing photo- and video- registration devices, microwave detectors, advanced diagnostics and a countdown table.

ADDITIONAL FUNCTIONS

- Continuous automatic control of the presence/absence of moving/stationary vehicles in the level crossing area.
- Automatic control of the protective signaling devices.
- Automatic signal generation that notifies of an emergency situation on a level crossing if a stationary vehicle is detected in the level crossing area (preliminary "Warning" signal if there is no notification of a train approaching and "Alarm" signal if such notification has been received).
- Real-time video transmission of the level crossing area to the duty operator and automatic video registration of all the events.
- Real-time self-diagnostics and back-up of data from the current state of the level crossing equipment.
- A lock of the barrier in the raised position and return to the lowered position of the previously lifted barrier devices if a vehicle is detected in the level crossing area.
- Uninterrupted operation for at least 8 hours if the external power supply is off.

Automatic level crossing protection system based on the Platform 2.0 system's architecture in an extended configuration with additional functions



DIGITAL COMMUNICATION AND LOUDSPEAKER WARNING SYSTEMS

for Railway and Mass Transit

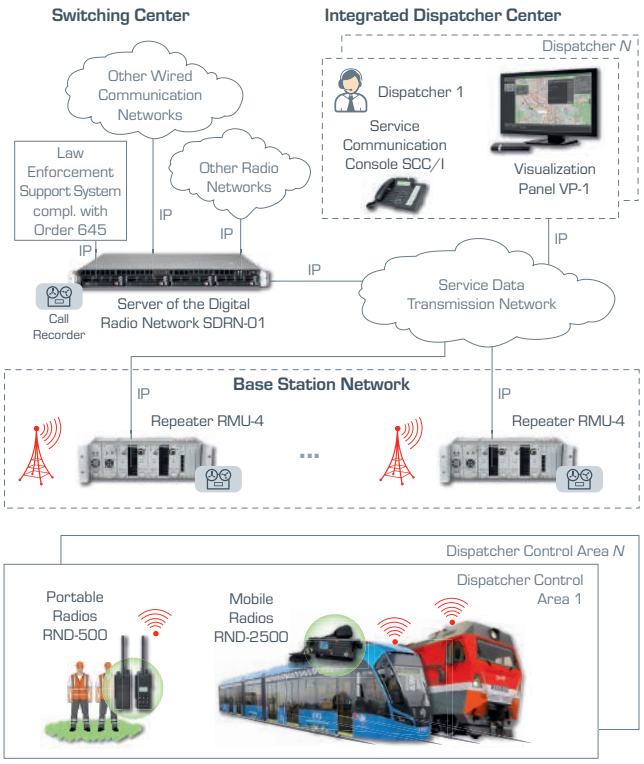
The Signaling Division of GC NPS provides mainline railways and urban mass transit with the RAIL Radio and RAIL Voice families for their digital service radio, dispatch communication, loudspeaker warning and clock systems.

DMR DIGITAL SERVICE RADIO SYSTEMS

Modern digital mobile radio (DMR) systems allow arranging a secure network of service radio communication with the following functions:

- individual, group and emergency calls with a call priority setting capability;
- text messaging;
- noise-proof data transmission for control and information systems;

Architecture of the DMR system



- centralized call recording;
- GPS- and GLONASS-based monitoring of the caller/subscriber location and speed;
- simultaneous operation in analog and digital mode;
- remote hardware monitoring.

IP PBX DISPATCHER COMMUNICATION SYSTEM

IP PBX based on the Sura platform is a versatile solution for a scalable industrial communication with a set of additional services and dispatch telephone communication capabilities. It is a completely Russian design with a high level of cyber security.

COMMUNICATION AND LOUDSPEAKER WARNING SYSTEMS

The SDPS-MDE communication and loudspeaker warning system is based on the modular principle to ensure high flexibility and scalability for implementing a range of configurations — from simple to complex. It allows managers of various levels receive remote operational access to any announcement zones.

An amplifier-based package UMK-4 provides a loudspeaker communication, automatic personnel warning within safety systems, message broadcasting for general public and displaying text information on an electronic board.

CSM CLOCK SYSTEM

The CSM clock system is intended to build a unified synchronized standard time network at the transport facilities, with potential to ensure complete redundancy for their hardware and communication channels. The standard time is displayed by digital and analog clocks.

LED LIGHT SYSTEMS AND SIGNALS

for Railway and Metro

The Signaling Division of GC NPS supplies reliable, durable and inexpensive LED light systems for installation in signal light units instead of a lens units with filament lamps (bulbs). They can serve as read, yellow, green, blue and lunar-white aspects of post-mounted and dwarf railway signals of the RAIL Signal family.

For the post-mounted railway signals, we propose the SSSM200-1 and SSSM200-1U LED light systems. Red and lunar-white SSSM200-1U devices with universal (AC/DC) power supply are used for aspects of the post-mounted signals with a local DC source used as a backup power supply. For the dwarf railway signals, we propose the SSSK160-1 LED light systems. All abovementioned devices comply with GOST 56057-2014 and are made according to the specification TU 3185-003-01404314-2009.

The Division makes a complete lineup of post- mounted and dwarf railway signals, gantry- and bracket-mounted signals made according to the specification TU TsSh 2141-2009 for railway transport, post-mounted and dwarf signals for overhead and tunnel installation made according to the specification TU 3185-007-01404314-2015 for metro and equipped with LED light systems, as well as LED indicators/signs, searchlights, pilot lights (tail/ditch lights), lighting fixtures and other lighting equipment.

All metal parts of the signals are galvanized, while their background boards and visors are made of durable impact-resistant polymer, which reduces costs for the signal maintenance and allows its operation without coating throughout the entire service life.

Specifications of SSSM200-1/SSSM200-1U and SSSK160-1		
Light output on the optical axis at 25 °C ± 10 °C, for the aspect color, in cd:		
red	2100 – 6000	1000 – 3000
yellow	3500 – 9000	2000 – 5000
green	2100 – 4500	1300 – 3000
blue	200 – 800	150 – 600
lunar-white	2500 – 5000	1800 – 3500
AC supply voltage at 50 Hz (for SSSM200-1U — AC or DC supply voltage), in V	$12{,}0\ ^{+1{,}2}_{-1{,}0}$ (day mode) $9{,}0\ ^{+1{,}0}_{-0{,}5}$ (night mode)	
Maximum power consumption, W	15	

LED light systems — SSSM200-1/SSSM200-1U (left) and SSSK160- 1 (right)

Dwarf, post-mounted and gantry-mounted railway signals with LED light systems

RELAY EQUIPMENT

for railway applications

Major mainline/industrial railways and metro networks still operate multiple conventional signaling systems based on relay technology. The Signaling Division of GC NPS is a leading manufacturer of relay products of the RAIL Relay family for the railway industry in Russia and other CIS countries.

CONTINUOUS DEVELOPMENT AND IMPROVEMENT

The Signaling Division of GC NPS specialists continuously improve design of the manufactured relays, seeking ways to improve their operational, technical and economic performance through the use of new technical solutions and modern materials. This allows increasing reliability and service life of both new and currently operating signaling systems.

Electromagnetic relays of NMSh and N types use innovative contacts, which provide stability of the relay electrical and mechanical characteristics throughout the service life.

In the compact neutral plug relay of NMSh type, modified form of the transfer contact has allowed avoiding an touch contact of front and transfer contacts. In addition, caps and mounting wires of such relays are made of non-combustible materials.

Another example is the pulse relay of IVG-KRM1 type, designed for AC track circuits operating at a frequency of 50 Hz and 25 Hz. It has two reed relays (main and backup) and an integrated control circuit performing automatic switch to backup relay if the main will fail.

The IVG-KRM1 type relay is equipped with an additional diagnostic output with dry contact, which opens upon a transition to the backup reed relay or failure of the monitoring circuit.

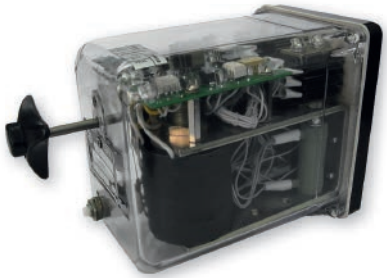
The IVG-KRM1 type relay has an enhanced overvoltage protection and a heating element, which is automatically turned on and off by the temperature control module. This type of relay can work in a wide temperature range.

A WIDE RANGE OF RELAY PRODUCTS

- The entire range of electromagnetic neutral relays of the NMSh, ANSh, PMPUSh, KMSh types.
- The entire range of electromagnetic relays of N, D3, DK3, C5, PLZU types.
- The entire range of electromagnetic relays of DSSh, KSh, IMSH, SKPR, PPR, IR types.
- The entire range of ETs, ETs–I.R, ETs-MN.R blocks, route set, DA decoder blocks and TSh cells.
- IVG-KRM1 pulse relays with monitoring and redundancy capability.

NMSh relay

IVG-KRM1 relay



N-2 relay

CABINETS, TRANSPORTABLE MODULES
and mobile sets

The Signaling Division of GC NPS focuses on providing all-in-one services, which include delivery of turn-key solutions and systems to end customers. The RAIL Housing product family includes a variety of racks and cabinets for equipment and backup batteries, transportable modules and mobile sets.

HIGH QUALITY CABINETS FOR SERVER AND TELECOMMUNICATION EQUIPMENT

19-inch on-floor cabinets are used primarily for placement of communication, telecommunication and server equipment. They have a welded frame, can be executed in several sections (up to four) and designed for a load of up to 1,500 kg. It is possible to use removable and non-removable panels and doors. The doors can be unglazed, glazed and with 85 % perforation.

Convenient side panel fasteners allow you to disassemble them quickly for speedy access of the maintenance personnel to the equipment. The internal elements of the cabinet are equipped with grounding. The cabinets can be equipped with cable organizers, fan panels and power distribution units.

Thermo cabinets in a vandal-proof case are designed for communication, telecommunication and signaling equipment and systems. These cabinets are set up in open areas. They have IP58 degree of protection and are equipped with air conditioning, fire fighting and monitoring systems. Thermo cabinets are designed for operation in harsh environmental conditions.

TRANSPORTABLE MODULES AND MOVABLE SETS FOR SIGNALING EQUIPMENT

Movable sets include sections of block containers, in which signaling and communication equipment is located. They are equipped with all the necessary devices for heating, air conditioning and ventilation, backup power supply, etc.

The Signaling Division of GC NPS makes mobile sets, including those for the following equipment:

- station equipment of interlocking systems;
- equipment of automatic line block signaling and automatic block-posts for sections of semi-automatic line block;
- level crossing signaling equipment;
- mobile control posts for the overall repair of the track, contact network and automatic line block signaling.

Cabinets made by the Signaling Division of GC NPS

Transportable module

RADIO-BASED TRAIN CONTROL SYSTEM

for the Trans-Mongolian Railway

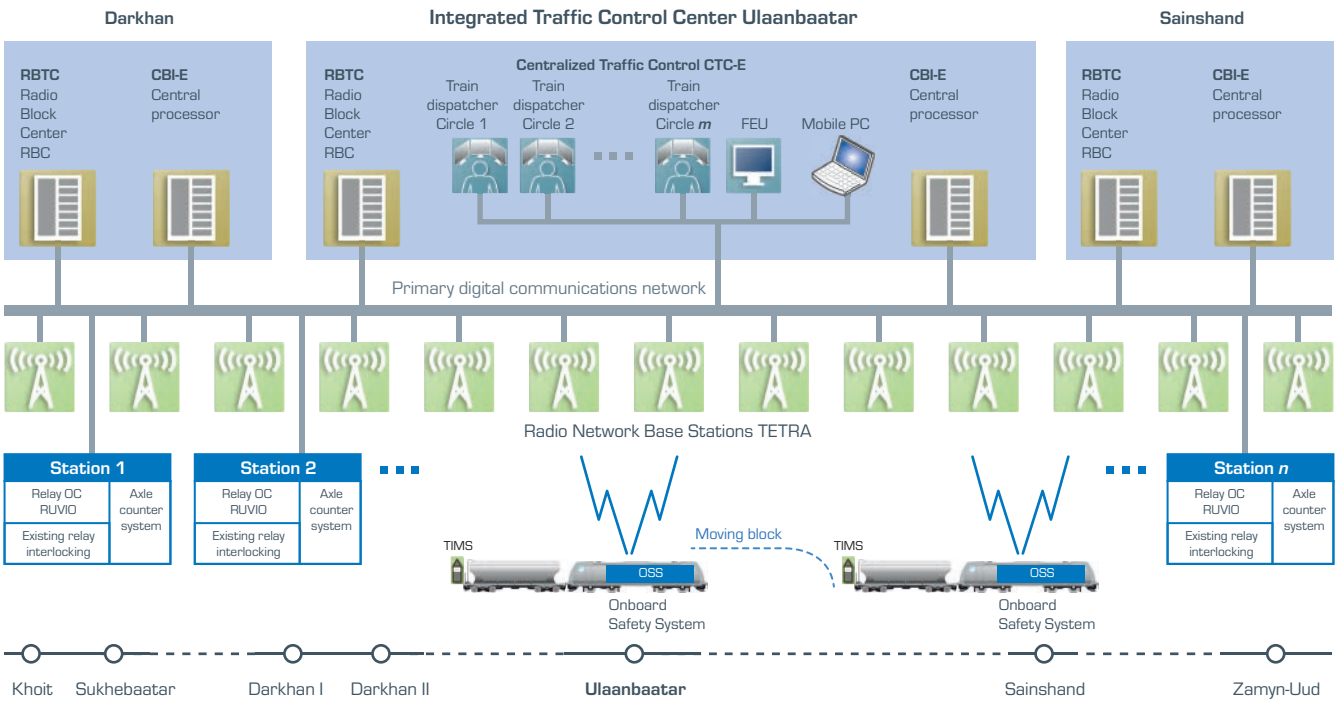
In 2015, the companies of the Signaling Division of GC NPS won the international tender for upgrading signaling systems on the Trans-Mongolian Railway, 1,111 km long and having 68 stations. They proposed a comprehensive technical solution, which both allowed meeting the budget and largely exceeded the process parameters set by the customer.

This large-scale project was implemented within record terms — after less than 3.5 years radio-based train control system with moving block technology was put into operation.

KEY COMPONENTS OF AN INTEGRATED SYSTEM

- Relay object controllers and the axle counter systems at the stations for integrating relay interlocking devices into the digital environment of the integrated system and train arrival control at the station.
- The radio-based train control system with data transfer between the radio block centers at the main stations and onboard safety systems via a digital radio network TETRA. The TETRA network is also used for a service communication on the Ulaanbaatar Railway.

Design of an integrated train control system for the Trans-Mongolian Railway



Traffic control center of the Trans-Mongolian railway

- Three CBI-E central processors at the main stations for implementing dependencies related to all train movements on the open line, including trains without onboard safety systems.
- The CTC-E centralized traffic control system at the integrated traffic control center, ensuring concentration of the traffic management over the entire Ulaanbaatar railway.

All these components are well tested and successfully operated in Russia, Kazakhstan and other "1520 area" countries. Under the Mongolian project, they were first combined into a unified integrated system.

Movement of the trains equipped with the ATP-E onboard safety systems is controlled by the moving blocks based on the tail of the train ahead. For trains that are not equipped with ATP-E, the traditional control mode is maintained, when only one train can present on an open line.

The radio-based train control system on the Trans-Mongolian Railway includes:

- three radio block centers located in Darkhan, Ulaanbaatar and Sainshand;
- track-mounted reference sensors (balises) installed between rails for correction train location data from onboard odometry equipment;
- onboard safety system and onboard train integrity management systems (TIMS).

INCREASED CAPACITY WITHOUT NEW INVESTMENTS IN INFRASTRUCTURE

An important advantage of the Trans-Mongolian Railway's integrated system is the ability to increase the line capacity only by expanding the fleet of locomotives equipped with the onboard safety systems with their concentration in areas requiring the maximum capacity. At the same time, no new investments in the infrastructure of the signaling devices are required. Thus, the Railway capacity will increase in accordance with the growing demand for transportation, which contributes to the quick payback of the integrated system.

The introduction of the integrated train control system on the Trans-Mongolian Railway allowed successful support of the growing transit traffic caused, among other things, by the higher amount of the container trains on the China — Europe route.

INTERLOCKING SYSTEMS

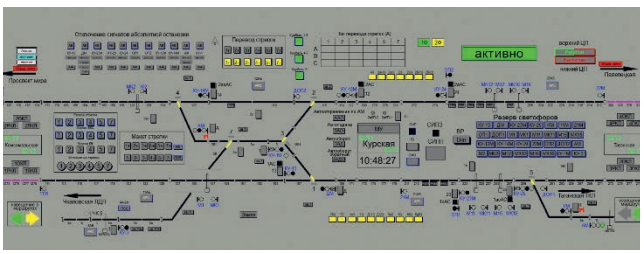
for metro: CBI-EL and RCBI-EL

The long-standing partnership of the Signaling Division of GC NPS with the Moscow Metro got to a new level when in April, 2021 CBI-EL was successfully commissioned in the electric depot "Sokol" (57 points) — the first computer-based interlocking system in the metro of the russian capital. In 2023 the CBI-EL systems were commissioned at all stations of the Moscow Metro Circle line and in four electric depots.

CBI FOR METRO: HIGHEST AVAILABILITY LEVEL

Uninterrupted train traffic with super-short headway in the Moscow Metro is a safety factor itself under conditions of the intensive passenger traffic flow. Therefore, the CBI-EL architecture for metro is designed for ensuring the highest availability level by means of hot standby of all its components, including the object controllers. In case of the main object controller failure, the switchover to the redundant controller is carried out automatically. The redundancy is also stipulated for the CBI-EL Central Processing Unit (CPU), all telecommunication equipment and local control and supervisory systems.

Mnemonic scheme of the station on the screen of the Local control and supervisory system (LCSS)



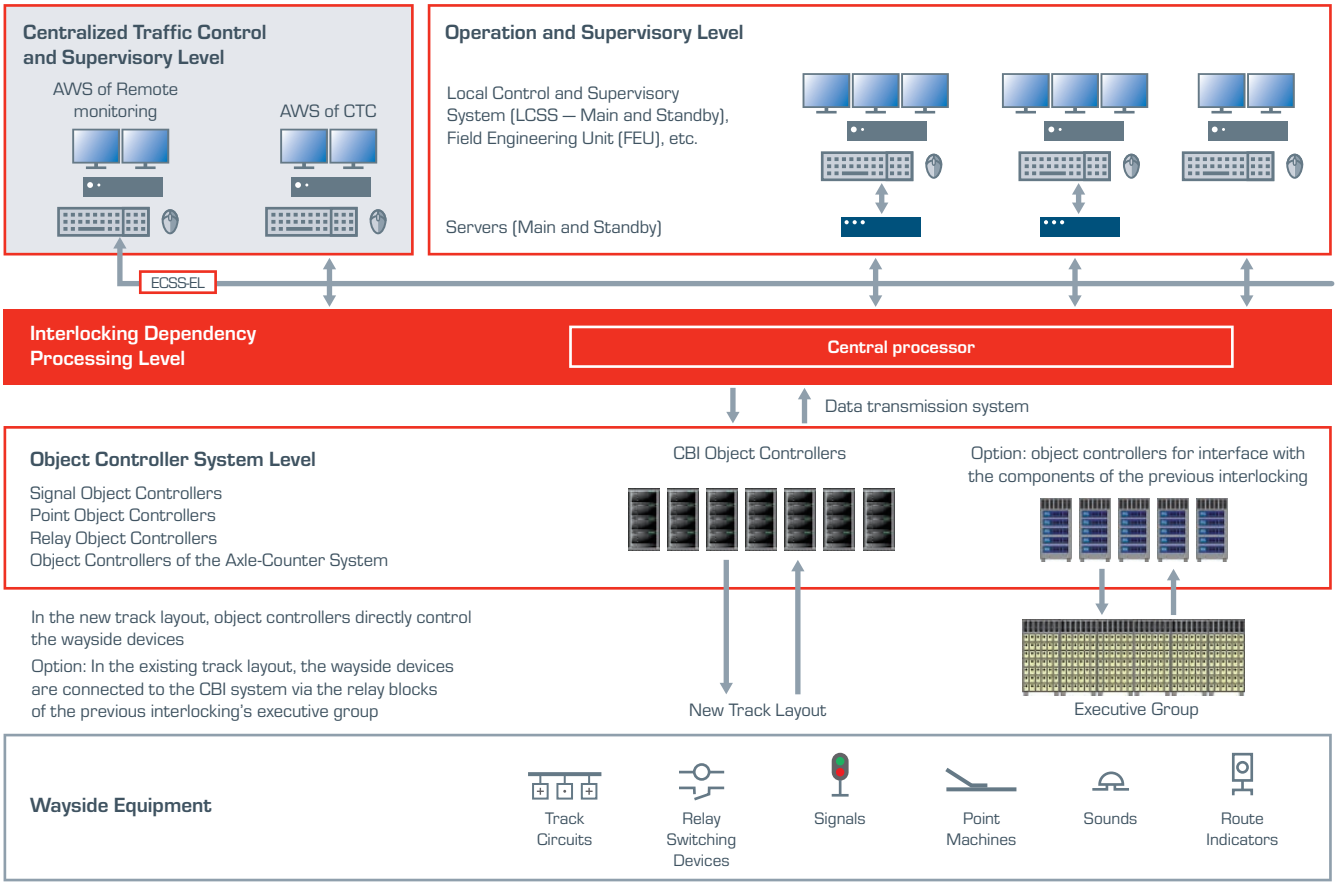
Due to the high dust pollution level in the metro tunnels caused by the train traffic, the CBI-EL systems are equipped with the central processors with passive cooling systems for heavy-duty service.

Digital modules of track circuits control (DM-TCC) controlled via software interface are used as a train control subsystem in CBI-EL for the Moscow Metro. The operational logic of this subsystem is implemented by the central processor of CBI which demonstrates its advantages in terms of flexible configuring. The modules generate and transmit to track circuits the codes necessary for the onboard system of automatic locomotive signaling ARS-ALS.

The system ARS-ALS enables controlling the train traffic using short block sections into which the traditional automatic line block section fenced by signals is divided. In this case the train driver is guided by signal indications in the train cab, and the speed is limited automatically depending on the train situation.

The CBI-EL system is produced on the domestic hardware platform and supplemented with the enhanced cybersecurity system which comprises a cybersecurity monitoring device and a system network traffic analysis sensor. Such sensor detects any attempts of unauthorized connection to the system's internal network.

The CBI-EL system for the metro implements functions of adjustment and monitoring of the points' electric parameters and track circuits via Field Engineering



ECSS-EL Enhanced cybersecurity system

Schematic diagram of the CBI-EL system with optional components of hybrid interlocking

Unit (FEU). This data is archived which enables prompt detection of malfunctions, and if required in emergencies, to make any necessary changes of the wayside devices' power supply parameters.

The CBI-EL architecture also allows creating the multi-station interlocking systems (such technical solution was implemented at the Moscow Metro Circle line) and efficient integration with any adjacent relay systems using controllers connected via fibre optic line.

HYBRID SYSTEMS: EFFICIENT MIGRATION TO DIGITAL TECHNOLOGIES

The hybrid system RCBI-EL allows modernizing the metro electric depots and stations without any train traffic interruption, enhancing reliability by means of the equipment redundancy. The system provides analysis and archiving of the train situation and operator activities data. Further on the full transfer to the computer-based technologies is possible without any additional investments. The combined version of the CBI and hybrid systems is being implemented in the "Uzbekistan" electric depot with control from the unified LCSS.

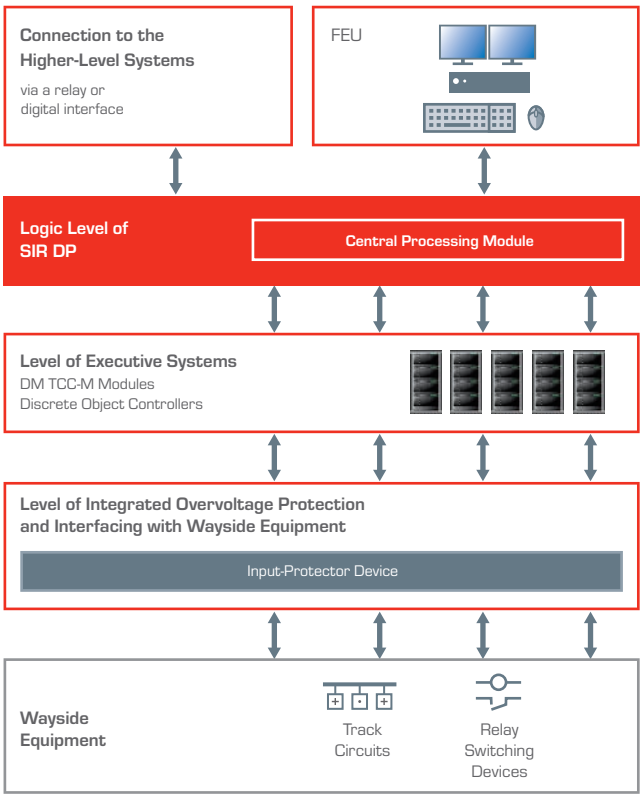
COMPUTER-BASED TRAIN CONTROL SYSTEM

for metro

The digital train control system based on the DM TCC-M digital track circuit monitoring modules, is an innovative solution of the Stalenergo company, part of the Signaling Division of GC NPS. The system ensures train movement safety at the stations and open lines featuring audio frequency track circuits with centralized equipment layout.

The digital train control system is based on AFTC and ATP coding and is already implemented at 57 stations of Moscow Metro and 9 stations of Tashkent Metro, where it has proven its high reliability and safety. This is an independent hardware/software solution focused on the train control both at individual stations and entire metro lines.

Structure of the computer-based train control system for metro



MODULAR DESIGN AND CONFIGURATION CAPABILITIES

The system features a modular design and wide range of configuration options depending on the needs of the metro:

- The basic configuration of the system includes a central processing module. This module implements the train control logic, controls the DM TCC-M modules, performs the system's status diagnostics and displays it on the FEU workstations. Also, it provides an interface with the higher-level computer-based and relay interlocking and automatic line block systems. This configuration is an out-of-the-box solution with the shortest response time. Such system is implemented at the Big Circle Line of Moscow Metro.
- The integrated configuration of the system, where the train control logic is implemented by the software of the upper-level CBI central processor. All DM TCC-M modules are connected to this higher-level CBI. This solution allows integrating the train control system into the existing CBI systems from any manufacturer. Such system configuration is applied at the Circle line of Moscow Metro.

When deploying the system during upgrade or new construction, at the first stage it can be connected to the existing relay automation systems, which can be further transformed into the computer-based interlocking systems at minimum costs. To do this, it will be enough to remove relay equipment, add the CBI-SM object controllers and upgrade the software of the logic core and visualization of the automated workstations.

The system implements the functions of automatic self-diagnosis with status data transfer to the diagnostic center.

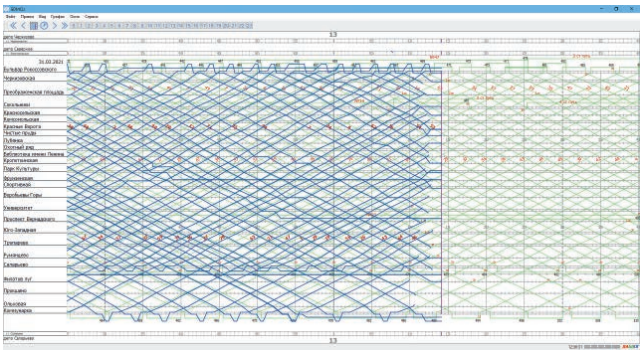
AUTOMATED CENTRALIZED TRAFFIC CONTROL SYSTEM

for metro “Dialog”

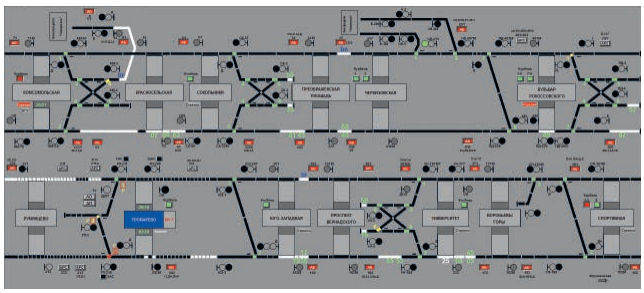
Efficient automated centralized traffic control in the metro and other mass transit systems is critical for maintaining uninterrupted transportation process and minimizing consequences of traffic failures in case of emergencies.

HIGH SAFETY AND RELIABILITY

The system’s functional safety complies with the rigorous requirements of metro. To enhance its reliability, the system uses only an industrial-grade hardware, and all its components are made redundant. All its critical hardware and software solutions are developed in Russia. Special attention is paid to the cyber security of the automated centralized traffic control system for metro “Dialog”. It implement a special measures to protect the transmitted telegrams from tampering and spoofing. Moreover, it applies an embedded protections, as well as operating systems and firewalls certified by the Federal Service for Technical and Export Control of Russia.



Display of the train schedule



Fragment of the Sokolnicheskaya line mimic diagram

The automated centralized traffic control system for metro “Dialog” is deployed at the Sergeliyskaya and Circle lines of the Tashkent Metro where the CBI-SM systems are connected to it. In the Moscow Metro within the scope of trial service the automated centralized traffic control system for metro “Dialog” provides dispatch control of the Troparevo station equipped with the CBI-EL system and dispatch supervision of all stations on the Sokolnicheskaya line.

The “Dialog” system was also put into trial operation at the Novokosino station on the Kalininskaya line of the Moscow Metro where it is connected to the CBI-SM interlocking.

ADVANTAGES OF THE AUTOMATED CENTRALIZED TRAFFIC CONTROL SYSTEM FOR METRO “DIALOG”

- Enhancing the train schedule performance by means of extending information, monitoring and diagnostic functions.
- High operational effeciency and labour comfort for the dispatch personnel.
- Up-to-date, convenient and easy-to-use interface.
- Reduction of operating costs due to the use of reliable equipment, process optimization and equipment power consumption reducing.
- Implementation of “Advisor” and “Automatic Dispatcher” modes.
- Compatibility with any station-level systems (relay, hybrid and computer-based types).
- Intelligent performed traffic schedule with functions of its best adjustment forecasting in case of any deviation from the planned schedule.
- Unlimited number of control and monitoring objects.
- High functional and information security.

AUTOMATED SYSTEM

for tram traffic integrated control

New tram lines are built and the existing tram lines are upgraded in the russian cities actively. In order to be operated efficiently and safely, the lower-level control signaling systems are necessary with subsequent integration of the tram into the unified mass transit control ecosystem.

In cooperation with the mass transit enterprises of the biggest russian megapolises, the Signaling Division has developed and implements the automated system for tram traffic integrated control. This system uses a radio communication to control the switches from the tram driver cabin and monitors its position which allows increasing switch section's passing speed and the tram line capacity.

COMPONENTS OF THE AUTOMATED SYSTEM FOR TRAM TRAFFIC INTEGRATED CONTROL

- Innovative point machine in different modifications for any operation conditions.
- Tram automation control cabinet in different modifications, including one with integrated switch heating system.
- Low-voltage heating control cabinet.
- Signals indicator of the point position.
- Radio-based tram traffic control system.
- Radioelectronic tram identification system.

The first automated system for tram traffic integrated control was commissioned for regular operation at more than 102 point machines, the onboard devices are adapted and integrated into the unified onboard tram system, including the most widespread tram model in Russia: “Vityaz”.

AUTOMATED SYSTEM FOR TRAM TRAFFIC INTEGRATED CONTROL FUNCTIONALITY

- Point machine position supervision and locking.
- Remote transmission of information about the point machine status to the driver using a light indicator installed above the switch or information screen of the onboard control and monitoring module located in the driver cabin.
- Remote radio-based control of the point machine from the driver cabin.
- Automatic switch operation according to the route of the approaching tram.

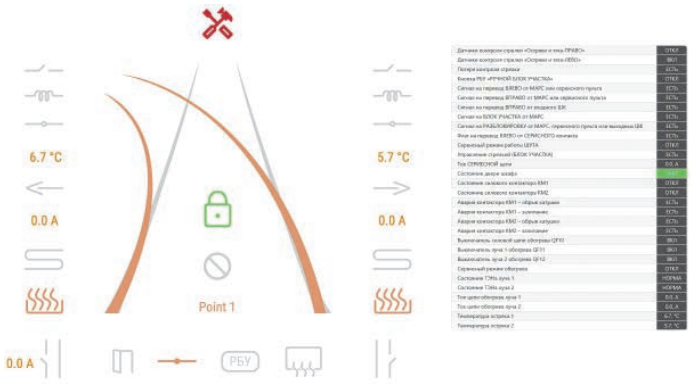
When the system is implemented, the existing aerial contacts and its functionality can be preserved. Once the whole tram fleet is equipped with the onboard automated systems for tram traffic integrated control, the aerial contacts can be removed. The system implementation is accompanied by the upgrade of the existing solenoid point machines with their additional equipping with the position monitoring sensors or installation of the new electromagnetic point machines with reference rulers and self-restoration after splitting the switch.

The onboard equipment of the automated system for tram traffic integrated control includes the control and monitoring module, controller with the route data base, a set of antennas and identifying tags reader. The wireless data exchange between the onboard system and the tram traffic control cabinet is carried out at citizen's radio communication frequencies using a secure cryptographic protocol.

THE AUTOMATED SYSTEM FOR TRAM TRAFFIC INTEGRATED CONTROL IS A KEY ELEMENT OF DIGITAL ECOSYSTEM

Equipping the whole rolling stock fleet with the automated system for tram traffic integrated control provides the wide range of options available for the unified dispatch centre also. The dispatcher can not only visually monitor the current tram position in the map, but also adjust the route, receive information about operation of the wayside equipment and trams via LTE radio communication network, including the data of the current speed, mileage, tram occupancy and even the driver's state.

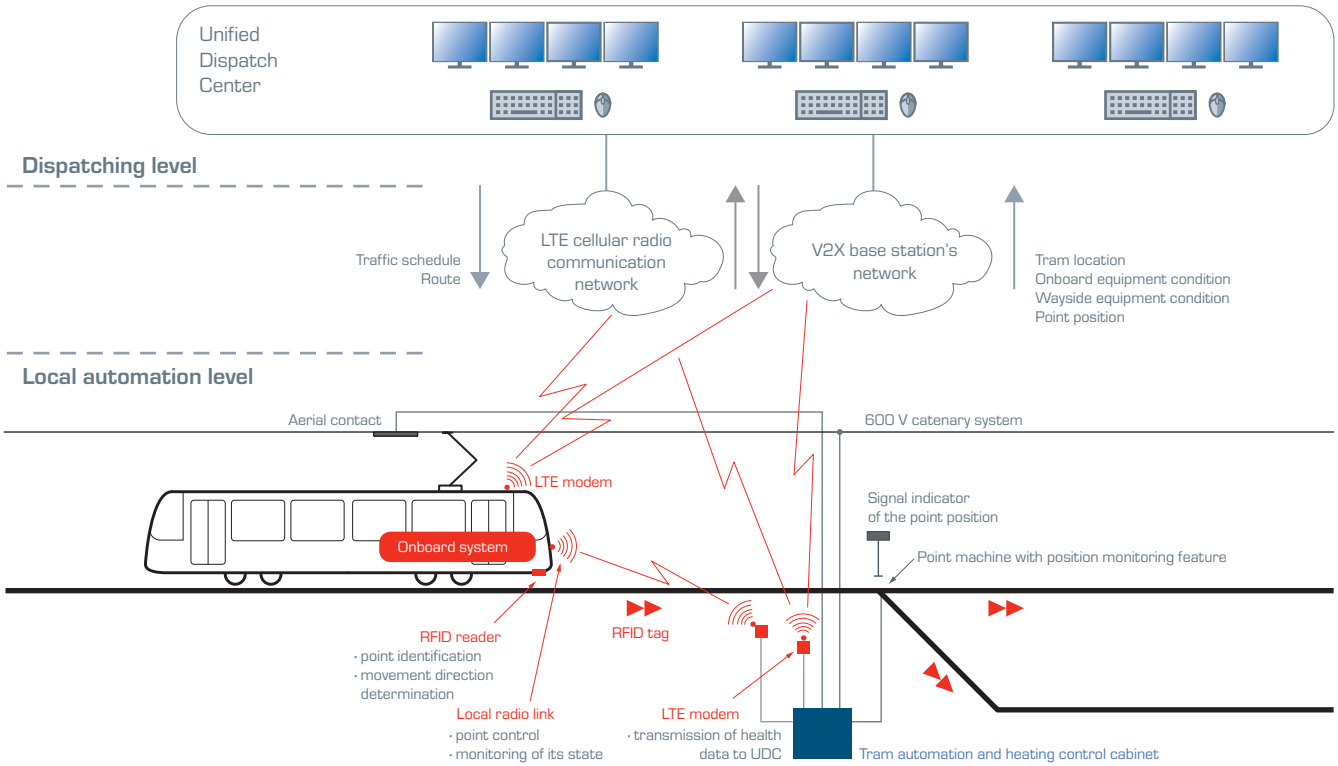
When the broadband communication with the unified dispatch center is deployed, the automated system for tram traffic integrated control will allow transition to the remote tram control and to the driverless tram further on. Automated system for tram traffic integrated control are deployed at 10 switches of the tram line in Strogino district in Moscow, where autonomous tram is being tested. This tram operates with software developed by Moscow Metro specialists.



LCSS for the tram automation control cabinet monitoring

Onboard control and monitoring module with a touch screen

Functions and main components of the automated system for tram traffic integrated control



THE SIGNALING DIVISION
of GC NPS

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employees

Staff

10
enterprises

Assets

9
countries

Geography

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Svobodnenskaya TPP in Amur region

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