NPS // SIGNALING DIVISION

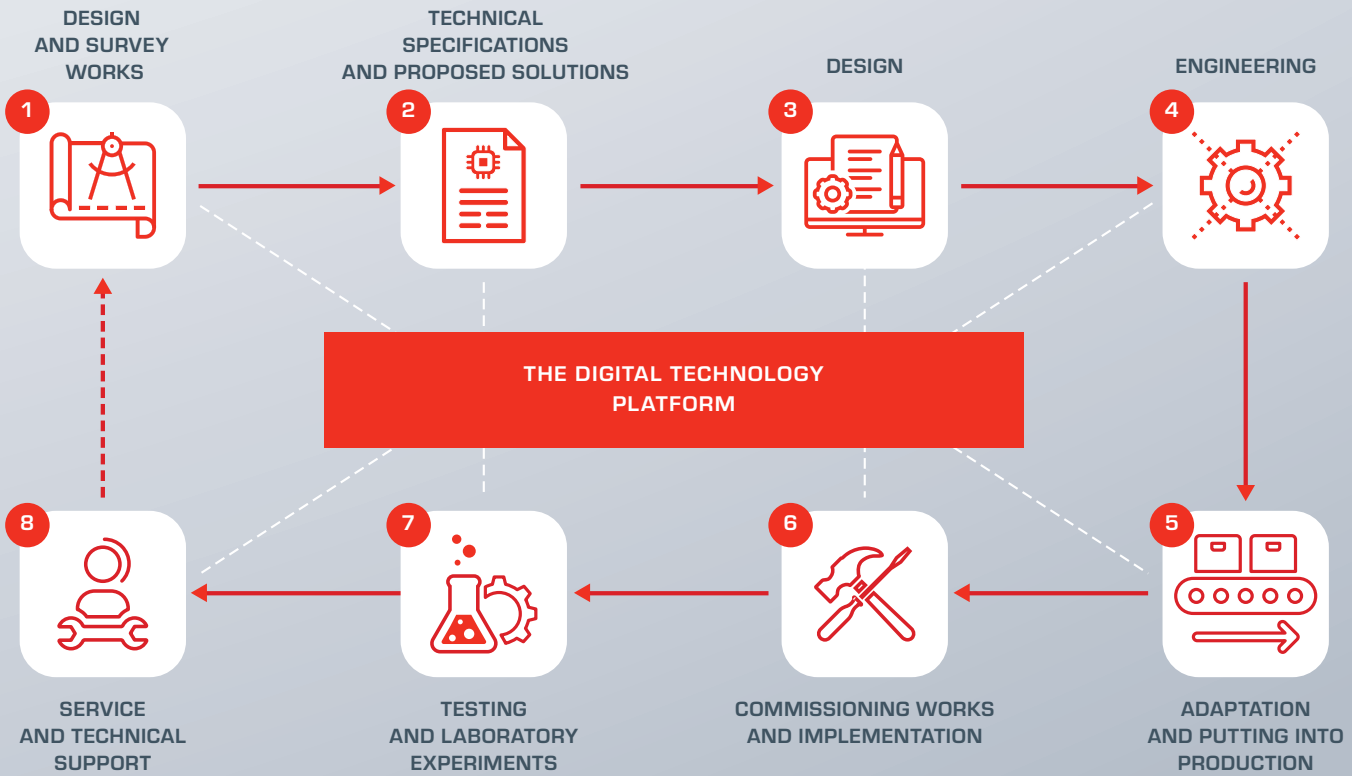
PRODUCTS AND SOLUTIONS OF THE SIGNALING DIVISION OF GC NPS

for mass transit

THE SIGNALING DIVISION of the Group of Companies Natsproyektstroy

The Signaling Division of the 1520 Group of Companies is one of the global leaders in production of the train control and safety systems. The Division unites the leading Russian companies that develop innovative technical solutions. Its project geography covers all CIS area, the Balkans, Turkey, Mongolia and other countries.

The Division provides a range of services throughout the entire life cycle of the signaling equipment for Metro and Tram.



MASS TRANSIT SOLUTIONS

of the Signaling Division of GC NPS

The Signaling Division of the Group of Companies Natsproyektstroy cooperates with the Metros of Russia and other CIS countries supplying various signaling devices — from the electric point machines to the computer-based systems.

Since 2018 the Signaling Division supplies the Metro of Moscow and Tashkent with up-to-date digital interlocking and train control systems, modular power supply systems along with the full range of relay and wayside equipment. In the Moscow Metro the digital systems have managed to provide the record short headway — 80 sec.

DIGITAL TRAFFIC CONTROL SYSTEMS

Computer-based and hybrid interlocking systems **CBI-EL, CBI-SM** and **RCBI-EL** in its metro modifications provide for the hot standby of all electronic components, including object controllers, data links and electronic equipment of track circuits. Thus, the maximum availability of the signaling systems and devices is ensured which is especially important at high-traffic mass transit lines where the uninterrupted train traffic is one of conditions for safe and sustainable transport system operation.

All electronic modules of interlocking systems for Metro are of dust-proof design. The CBI systems are supplemented with the enhanced cybersecurity systems which ensure connection to the remote monitoring LCSS in the unified metro control centre and guarantee the protection of the system internal network against cyber attacks from external networks.

The Digital Train Control System based on reliable and functional **Digital Track Circuit Monitoring Modules (DM-TCC-M)** with audio frequency track circuit coding using ARS frequencies became widely spread in the Moscow and Tashkent Metro. These modules are connected to the interlocking systems via digital or relay interface.

The digital signaling systems proven-in-use in the Moscow and Tashkent Metro are capable of ensuring reliable train control in mass transit sector of other cities of “1520 area”.

MASS TRANSIT KEY TECHNOLOGIES AND PRODUCTS

- Computer-based and hybrid interlocking systems.
- Digital train control system.
- Workstation system.
- Automated train management system for metro.
- The Automated system for tram traffic integrated control.
- Enhanced cybersecurity systems.
- Electric point machines.
- Signals, signs and markers.

MILESTONES OF IMPLEMENTING

Signaling Division of GC NPS digital systems for mass transit

HYBRID INTERLOCKING SYSTEMS HIS-EL

In 2018 the first **hybrid interlocking system RCBI-EL** was implemented in the Moscow Metro. Thereby an important preparatory step was carried out in order to deploy digital signaling systems in the capital's Metro. Three RCBI-EL systems are used in the electric depots of the Moscow Metro now.

THE FIRST MODULAR COMBINED POWER SUPPLY UNITS IN THE METRO

At the end of August, 2018 seven new stations of the Solntsevskaya line of the Moscow Metro were opened. Five of them were equipped **with modular combined power supply units (MCPSU)** manufactured by Signaling Division of GC NPS. Now MCPSU are implemented at 74 stations of the Moscow and Tashkent Metros providing reliable power supply for the computer-based interlocking systems.

THE FIRST COMPUTER-BASED DIGITAL TRAIN CONTROL SYSTEMS

In June, 2019 **computer-based digital train control systems (DTCS)** were commissioned on the basis of a Digital Track Circuit Monitoring Modules (DM-TCC) at eight stations of the Sokolnicheskaya and Nekrasovskaya lines of the Moscow Metro.

By midyear 2023 such systems were implemented at 64 stations of the Moscow and Tashkent Metro. The innovative traffic control systems (TCS) provide the capacity of at least 48 trains per hour, per direction.

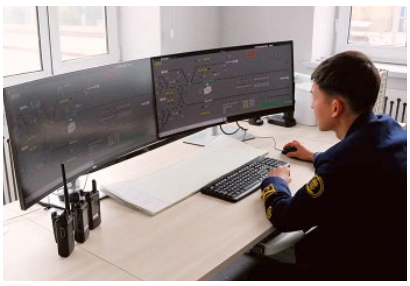
RUVIO relay controllers of RCBI-EL in the Moscow Metro Solntsevo electric depo

The Moscow Metro Circle line is switched under the digital signaling systems control

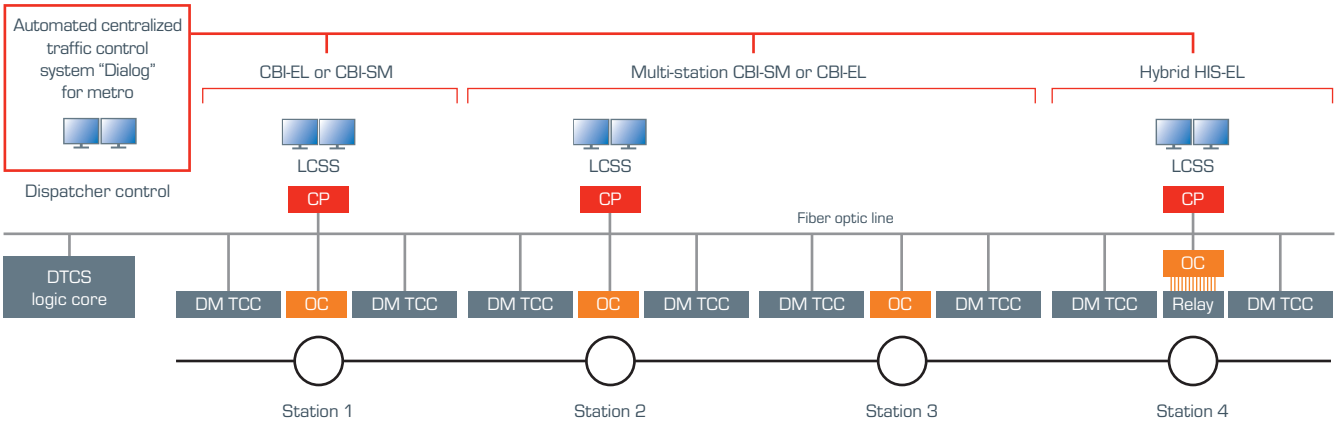
The wayside equipment of the signaling systems in the Moscow Metro

The Circle line of the Tashkent Metro is ruled by the digital signaling systems

LCSS of the "Dialog" system in the Tashkent Metro



The automated system for tram traffic integrated control is actively installed in Moscow on the tram lines



DTCS Digital train control system based on DM TCC modules

CP CBI central processor

OC Object controller

The Signaling Division train control systems for Metro

THE FIRST-EVER CBI-EL IN THE MOSCOW METRO

CBI-EL, the first computer-based interlocking system in the Moscow Metro, was commissioned in the Sokol electric depot on the 9th of April, 2021. This system is produced out of the domestic hardware components and adapted for the metro conditions. Before implementation it was tested at the Troparevo station. By midyear 2023 the CBI-EL systems were operated at 12 stations of the Circle line and in two electric depots. The Metro Circle line of the Russian capital was switched to the digital signaling systems in January, 2023 without any traffic interruption.

THE CBI-SM SYSTEM IN MOSCOW AND TASHKENT

In 2020 comprehensive tests of the **computer-based interlocking system CBI-SM** were completed successfully at the Novokosino station. It is the second CBI system developed and produced by the Signaling Division of GC NPS for the Moscow Metro. In the Tashkent Metro the CBI-SM system is installed at 20 stations of two lines—the Sergeliyskaya line and the Circle line.

DIGITAL CENTRALIZED TRAFFIC CONTROL SYSTEM "DIALOG"

The computer-based centralized traffic control system "Dialog" is successfully deployed at mainlines with the total length of 7000 km in different countries. Its modification for Metro was put into trail operation on the Sokolnicheskaya line of the Moscow Metro and on the Sergeliyskaya and Circle lines of the Tashkent Metro where the digital interface is provided by the CBI-SM system.

The automated centralized traffic control system "Dialog" takes the traffic management to a new level ensuring the possibility of optimum adjustment of the train schedule for fast return to the target indices. The adjusted schedule data can be used for further automatic metro train operation (ATO).

DIGITAL TRAM SIGNALING SYSTEMS

An important event happened in the history of the Moscow tram in 2021—**the automated system for tram traffic integrated control** passed tests successfully and was certified for implementation on the Moscow tram lines.

By March 2025 it was installed on 64 point machines and integrated into the unified tram onboard system. The automated system for tram traffic integrated control is the basis of a digital ecosystem which will allow transfer to the remote tram control and to the driverless tram operaion afterwards.

INTERLOCKING SYSTEMS

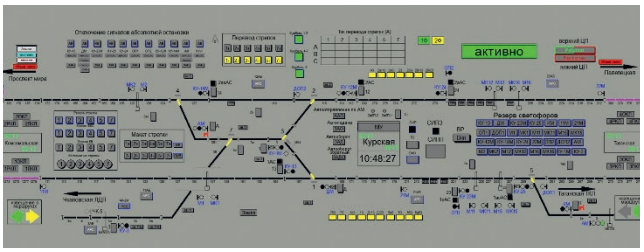
for metro: CBI-EL and RCBI-EL

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)



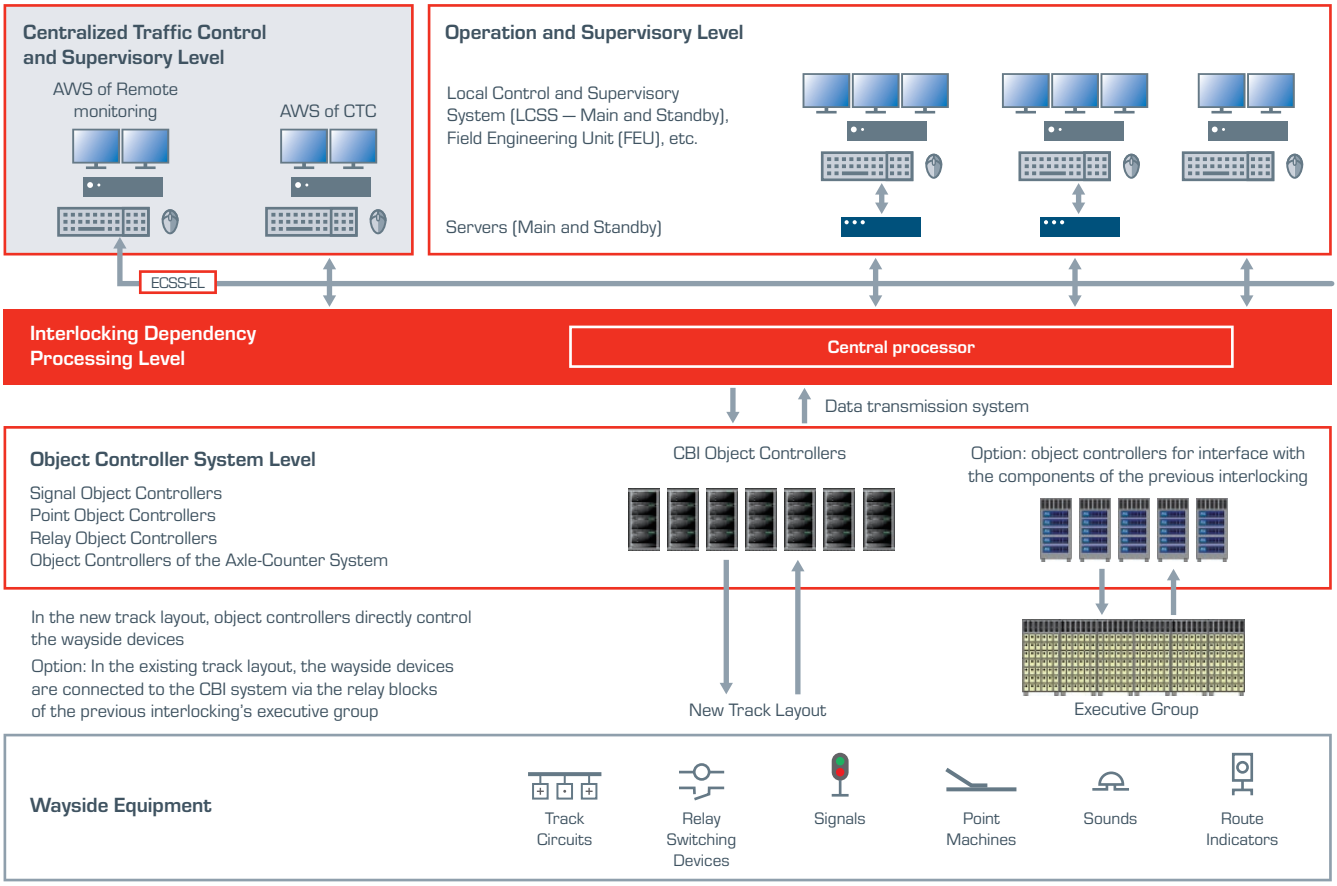
Due to the high dust pollution level in the Metro tunnels caused by the train traffic, the CBI-EL systems are equipped with the central processors with passive cooling systems for heavy-duty service.

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 INTERLOCKING

for metro: CBI-SM

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.

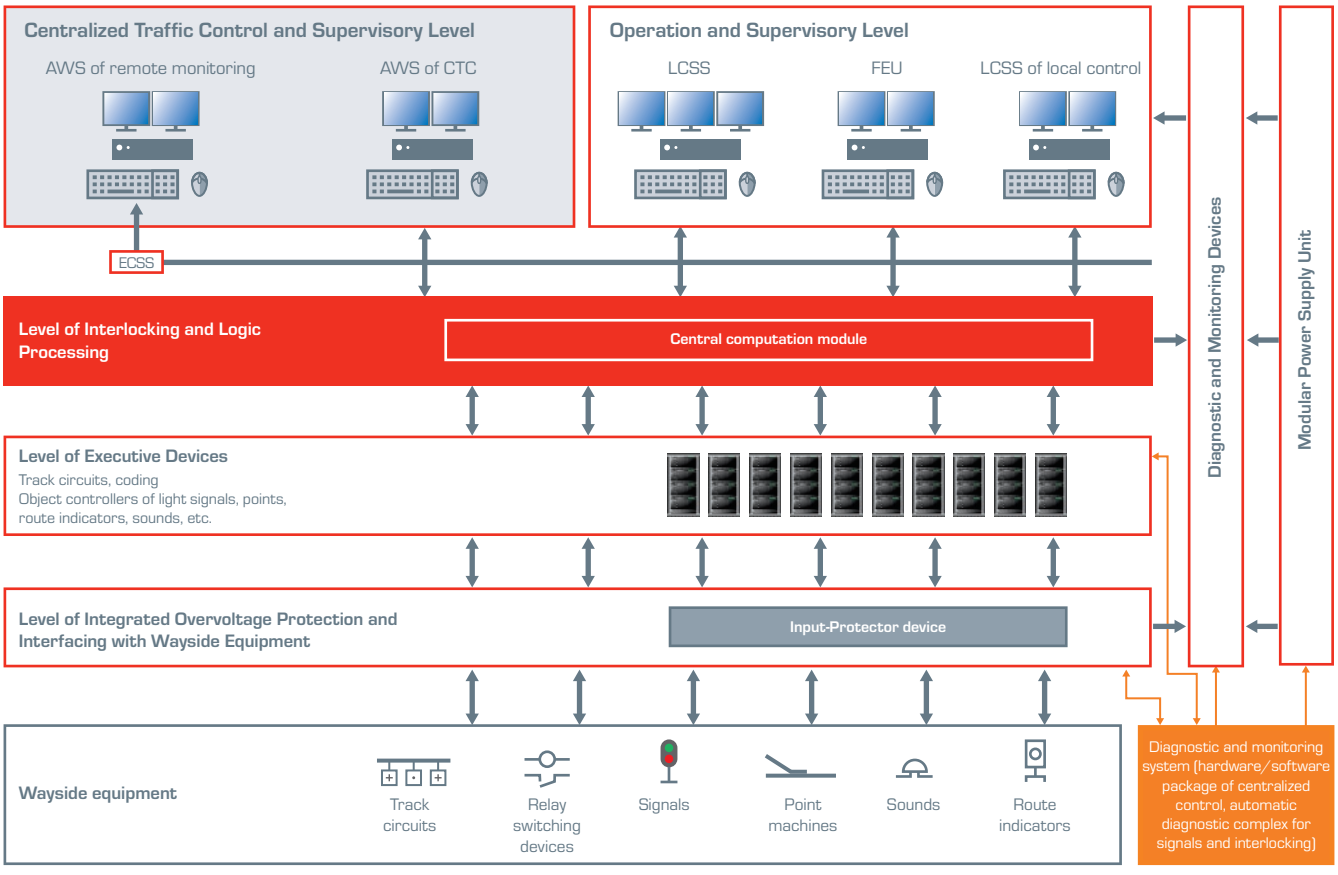
The computer-based interlocking system CBI-SM is designed for the inter-station metro line sections, stations (including stops without additional tracks) and in the electric depots both during new construction and modernization or reconstruction of signaling devices. CBI-SM can be deployed in several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



ECSS enhanced cyber security system

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.

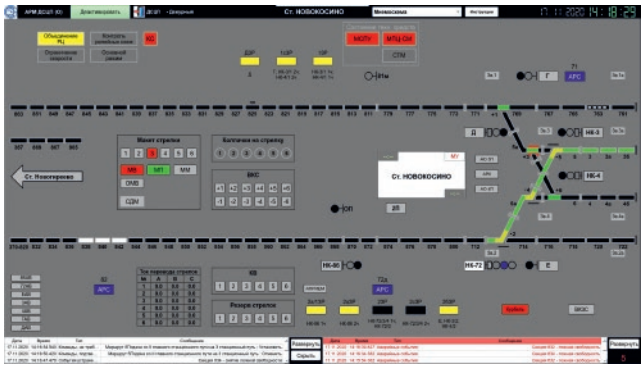
An innovative monitoring and diagnostics subsystem takes the CBI-SM system maintenance and operation to the qualitatively new level. It provides event archiving, graphical visualization of the monitored parameters, and an intuitive interface using web technologies.

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.

CBI-SM controller boards

LCSS interface in the CBI-SM system

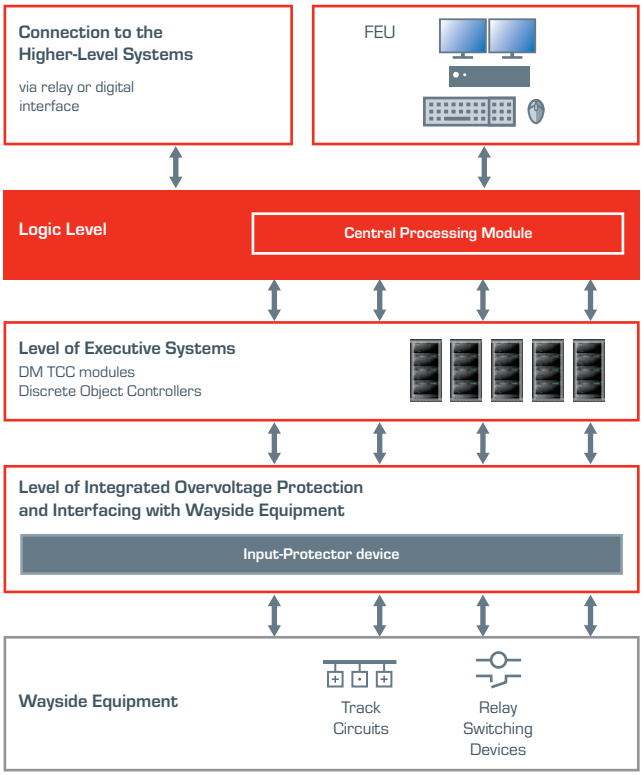


In Tashkent Metro, six stations of the Sergeli line opened in December 2021. Moreover, since 2022 CBI-SM is deployed at 14 stations of the elevated Circle line "30th Anniversary of Independence of Uzbekistan" featuring a multi-station design — one CBI package per two metro stations. All stations are 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.

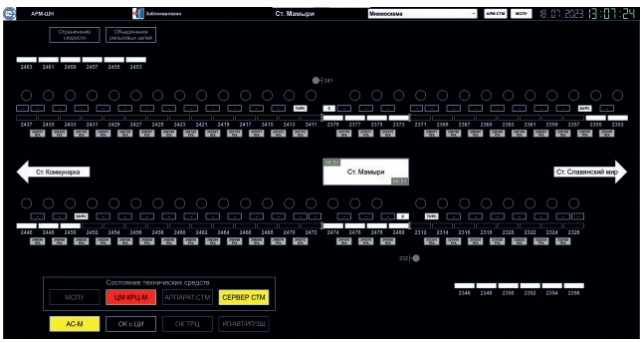
DIGITAL TRAIN CONTROL SYSTEM

for Metro

The digital train control system DTCS based on the digital modules of track circuits control (DM-TCC-M) is an innovative solution of Stalenergo Ltd.—one of the Signaling Division companies. The system ensures safety of the train movement at open lines and stations equipped with the audio frequency track circuits with the centralized equipment layout.



DTCS system structure



FEU interface in the DTCS

The digital train control system is based on ARS-ALS coding and is successfully implemented at 57 stations of the Moscow Metro and 9 stations of the Tashkent Metro where it has proved its high level of reliability and safety. Actually, this system is a standalone hardware-and-software solution focused on the train control both at individual stations and entire metro line.

MODULARITY AND CONFIGURABILITY

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

- **The basic configuration of the DTCS 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 DTCS 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 digital train control system during upgrade or new construction, at the first stage it can be connected to the existing relay-based 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.

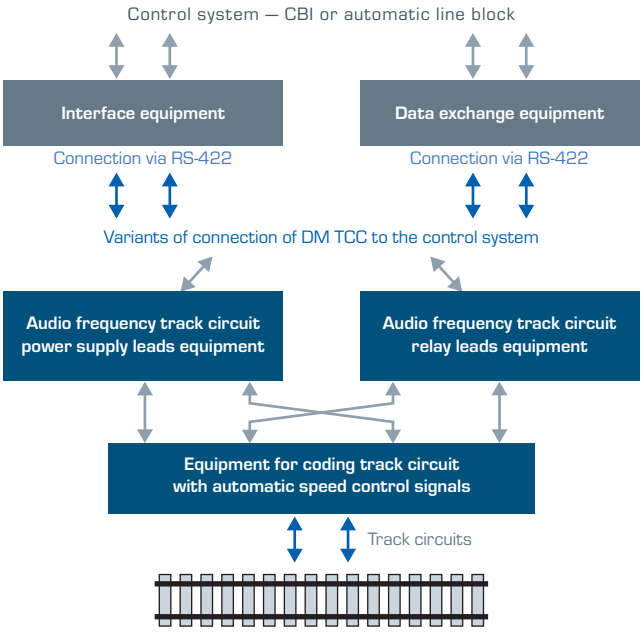
FUNCTIONS

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 ARS codes 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 TCS BASED ON DM-TCC

- 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 automatic cab signaling 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.



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

SHORT RESPONSE TIME

In January, 2023 during inspection of automation system at the Circle line of the Moscow Metro the TCS based on DM-TCC modules in conjunction with CBI-EL provided the capacity of 45 trains per hour in each direction. The train interval amounted to 80 s—it is the best index among all the Metros in the world.

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.

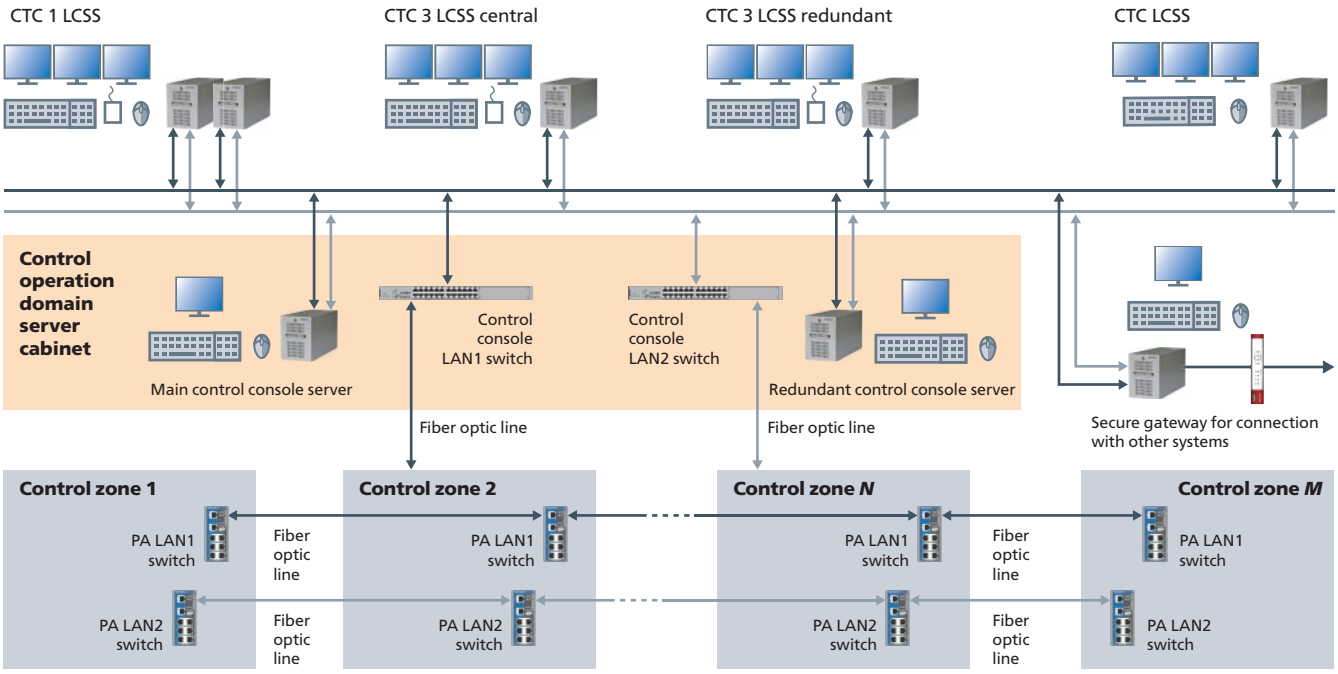
The automated centralized traffic control system for metro “Dialog” of the Signaling Division of GC NPS is built on the basis of the computer-based CTC “Dialog” which is operated successfully on the mainlines with the total length of over 7000 km in Russia, Belarus, Kazakhstan and Uzbekistan. This system is installed, in particular, at the Moscow suburban railroads with high traffic density.

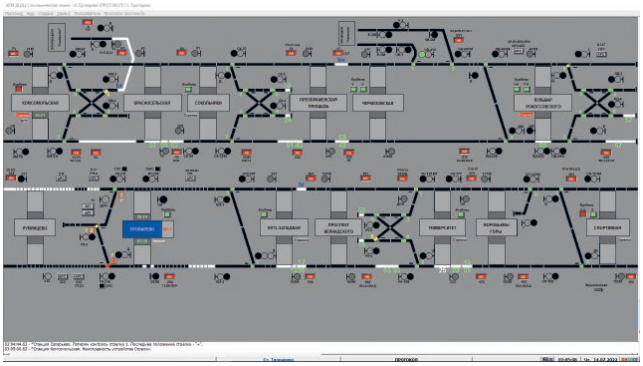
The automated centralized traffic control system for metro “Dialog” is deployed at the Sergeliyskaya and Circle lines of the Tashkent Metro where the CBI-SM systems are connected to it. In the Moscow Metro within the scope of trial service the automated centralized traffic control system for metro “Dialog”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

HIGH SAFETY AND RELIABILITY PERFORMANCE

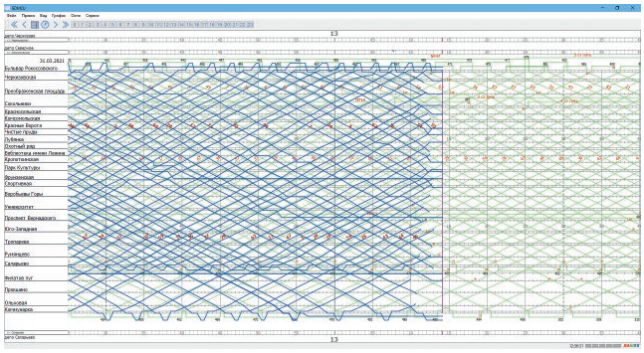
Functional safety of the system complies with the tough requirements of the Metro and the railroad transport. To enhance reliability, only industrial-profile equipment is used in the system, and all main components are made redundant. All critical hardware and software tools were developed by “Dialog-trans” Company and its russian partners.

Structure of the automated system for metro train traffic dispatch control “Dialog”





A fragment of the mnemonic scheme of the Sokolnicheskaya line



Train schedule display

Special attention was paid to information security of the automated centralized traffic control system for metro "Dialog" — special measures have been implemented for protection of the transmitted telegrams against tampering and diddling. There are also used the integrated protection tools, FSTEC-certified operation systems and inter-network screens.

HIGH FUNCTIONALITY

The automated centralized traffic control system for metro "Dialog" is in exact accordance with the functional requirements applied to such systems in the general development concept adopted by the Moscow Metro.

Alongside with the basic functions of monitoring and control of the station objects and displaying the scheduled, forecast and performed train schedules, the system acquires data of the station and onboard equipment condition which will allow taking timely measures of dispatch control if pre-failure occurs, prevent from the train traffic failures and transfer to the condition-based maintenance.

The automated centralized traffic control system for metro "Dialog" is capable of mutual connection and data exchange with any higher-level and lower-level systems, including other dispatch control systems, various CBI types, RBTC, SCADA systems, etc.

EFFICIENT INVESTMENT PROTECTION

Flexible and up-to-date architecture of the automated centralized traffic control system for metro "Dialog" ensures efficient scalability and possibility of further automation upgrade with implementation of new functions which will be highly desired in the future. It allows the customer to easily protect investments in its implementation and upgrade the system functionality in accordance with the requirements.

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.

MODULAR COMBINED POWER SUPPLY UNIT

MCPSU

Stalenergo Ltd. which is one of the Signaling Division companies has been implementing modular combined power supply units (MCPSU) at the Moscow and Tashkent Metro stations since August, 2018. They provide reliable uninterrupted power supply of the computer-based and relay signaling devices. Modular design of such units facilitates its configuration for the conditions of a specific implementation object.

MCPSU ADVANTAGES

- Automatic or manual switch of the load from one feeder to another in case of power failure or overvoltage, incorrect phase sequence or open-phase fault in an operating feeder.
- Uninterrupted power supply of the train control equipment.
- Galvanic isolation between the power sources and the signaling train control equipment loads.
- Protection against lightning and surge overvoltages on input circuits of external AC sources.
- Automatic monitoring of insulation resistance decrease in power supply circuits of the signaling objects' loads.
- Compatibility with any grounding system.

MCPSU cabinets of Stalenergo Ltd

- Operation in equal feeders mode or with priority of feeder 1 or feeder 2.
- Measuring values of voltage and current in feeder phases, voltage in load power supply circuits and current in battery circuits using switchboard instruments.
- Emergency shutdown of external power supply sources and batteries from the signaling objects' loads.
- Light alarm of the condition of feeders, units, circuit breakers, reduction of electric resistance in one of the monitored circuits.
- Remote alarm of the MCPSU devices condition using potential-free contacts and Ethernet.
- Real-time display and archiving the MCPSU devices condition at MCPSU and higher-level automated workstations.

HARDWARE VERSIONS

Stalenergo Company supplies the Metro with modular combined power supply units of two types:

- MCPSU-20-03-M Ets for relay systems with a power rating up to 20 kVA and
- MCPSU-40-02-MD for computer-based signaling systems with a power rating up to 40 kVA.

The latter has several modifications for different voltages of the input 3-phase current 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.

By mid-2023 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.

DIGITAL SYSTEMS FOR TRAIN CONTROL

on the Moscow Metro Circle line

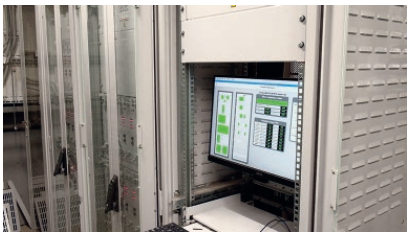
The Signaling Division has implemented a unique project of the signaling systems complete upgrade on the Moscow Metro Circle line. Some of them have operated for nearly 70 years without any traffic interruption.

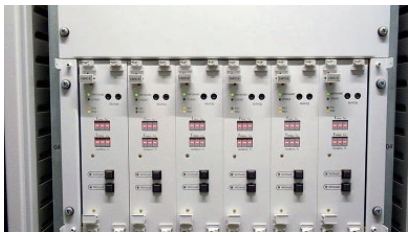
Office and process rooms of the Metro were used for deployment of the computer-based equipment because the existing relay devices had to function before the launch of the new systems. The GC NPS professionals had to carry out a vast scope of works in these premises: probing and other activities for diverting the ground water, upgrading air conditioning, fire extinguishing, communication and power supply systems.

The works in the tunnels were carried out during night train traffic interruptions. Then the connection diagram for 295 track circuits was upgraded completely at open lines and stations.

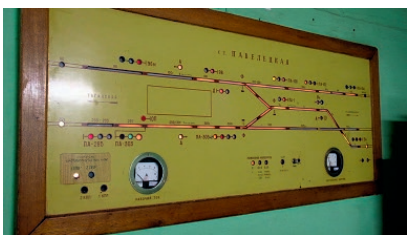
At the final stage in early January, 2023 the Circle line was operated in one direction only—first counter-clockwise, then clockwise. In those days the professionals were connecting the wayside equipment to the digital train control systems. Six CBI-EL systems have been implemented on the Circle line, each controlling two stations and being connected to the dispatch control system. Now 36 trains per hour per direction transit along the Circle line instead of the previous 34 ones.

FEU, the CBI-EL equipment cabinets and train control units at the Paveletskaya station after implementation of the digital systems





The track indicator with track layout mimic, operating console and relay equipment which were operated at the Paveletskaya station since 1954



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 64 point machines in Moscow, 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.

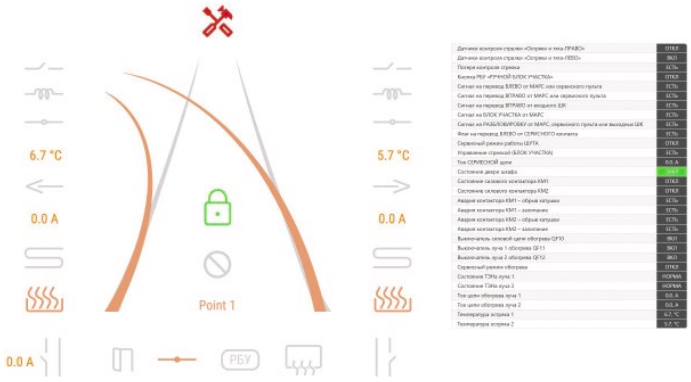
When the system is implemented, the existing aerial contacts and its functionality can be preserved. Once the whole tram fleet is equipped with the onboard automated systems for tram traffic integrated control, the aerial contacts can be removed. The system implementation is accompanied by the upgrade 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.

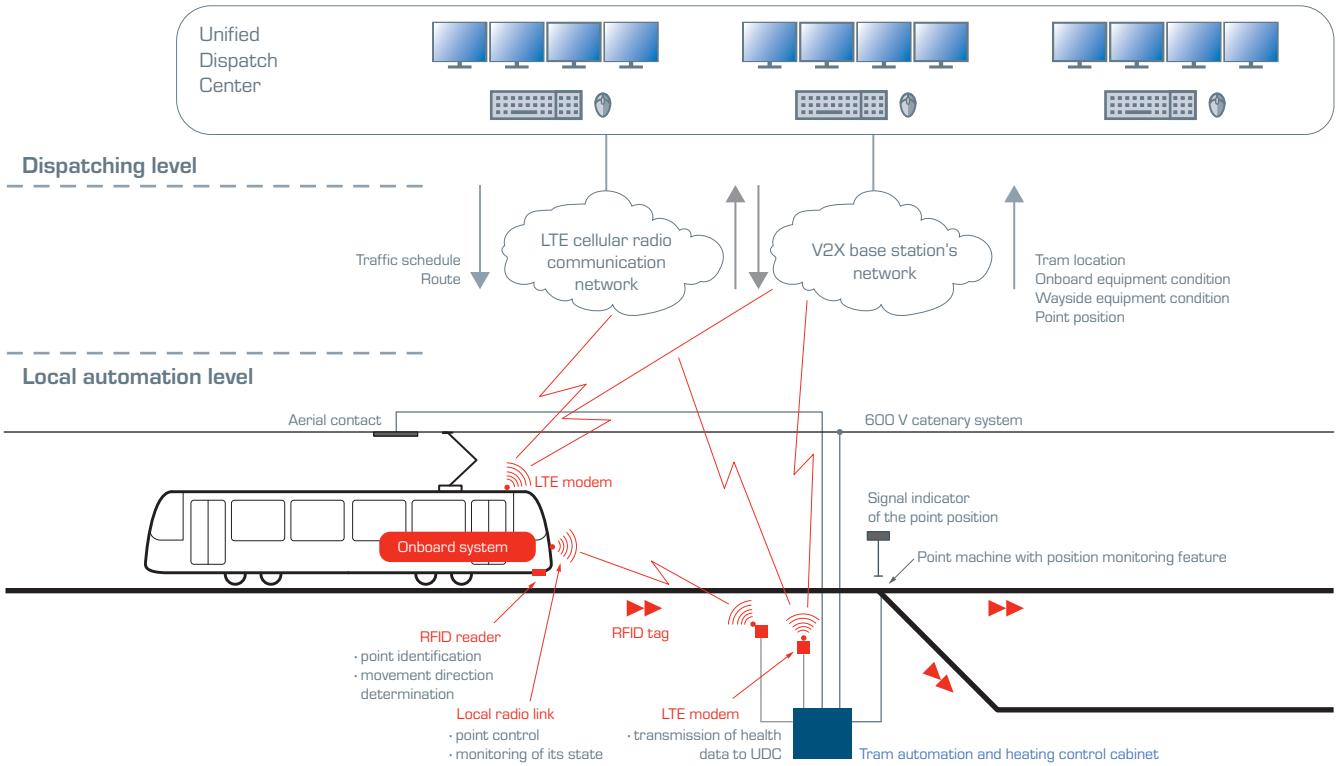
When the broadband communication with the unified dispatch center is deployed, the automated system for tram traffic integrated control will allow transition to the remote tram control and to the driverless tram further on. Automated system for tram traffic integrated control are deployed at 10 switches 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



DIGITAL COMMUNICATION AND WARNING SYSTEMS

for mass transit

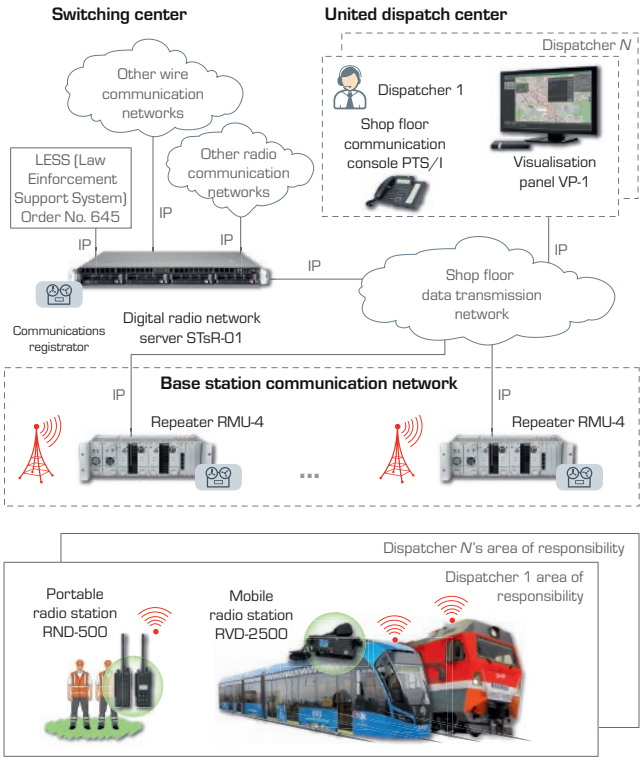
The Signaling Division of GC NPS supplies the digital communication, dispatch communication, loudspeaker and master clock systems.

DMR DIGITAL COMMUNICATION SYSTEM

The up-to-date professional mobile radio communication system of DMR standard allows arranging a secure technological radio communication network which provides:

- individual, group and emergency calls, call prioritization;
- text message transmission;
- noise-free data transmission for control and information systems;
- centralized voice communication logging;
- subscriber location and movement speed monitoring on the basis of GLONASS and GPS data;

DMR mobile radio communication system architecture



- possibility of simultaneous operation in analog and digital mode;
- equipment condition remote monitoring.

IP-ATC DISPATCH COMMUNICATION SYSTEM

IP-ATC on the "Sura" platform is a versatile solution for arranging a scalable network of industrial communication with a set of optional services, as well as dispatch telecommunication. It is a fully domestic development with high information security level.

DOUBLE-WAY FLEET COMMUNICATION AND LOUDSPEAKER WARNING EQUIPMENT

The Double-Way Fleet Communication and Loudspeaker Warning Equipment SDPS-MDE is based on the modularity approach and ensures high flexibility and scalability for implementation of configurations of various complexity. Managers of different levels use it to get remote access to any alert zones.

The system based on UMK-4 amplifiers provides loudspeaker communication, automatic personnel alert in security systems, transmission of messages for passengers and displaying text information on electronic boards.

MASTER CLOCK SYSTEM

Master clock system is designed to support a unified synchronized precise time network at the transportation facilities with the possibility of the equipment and data complete redundancy. The precise time is displayed on the electronic and analog clock/board.

THE SIGNALING DIVISION of the Group of Companies Natsproyektstroy

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