Developments in the Scientific and Technical Complex for Transportation Management of the Research and Design Institute for Information Technology, Signaling and Telecommunications on Railway Transport (NIIAS). From automating production processes to making statistics reports

Efim Rozenberg – first deputy director general of JSC NIIAS
Sergey Filipchenko – director of the scientific and technical complex at NIIAS
Sergey Kalinin – head of the station work technology modeling department at NIIAS
Alexey Ozerov – head of the international cooperation department at NIIAS

НИИАС

Russian Railways Assets

Infrastructure	
The operational length	85 513 km
The length of electrified lines	43 759 km
The length of tracks	104 563 km
Number of stations	5 428

Rolling stock	
Freight wagons	more than 1 000 000
Passenger wagons	about 40 000

Freight	
Freight transported in 2017	1 261,3 million tons
Freight turnover in 2017	3 176,2 billion tariff ton-km

Passenger	
People transported in 2017	1 118 million
Passenger turnover in 2017	122,8 billion passenger-km

Statistical reporting and primary documentation in JSC RZD

Currently JSC RZD is using:

✓Internal statistical reporting forms - 255 pcs;
✓Primary documentation account forms -1,079 pcs

For automated generation of 145 internal statistical reporting forms, we use 112 automated primary account forms with application of electronic digital signatures, including:

33 in locomotive complex;
19 in carriage facilities;
11 in track facilities;
35 in electrification facilities;
12 in freight complex;
2 in automation and telemechanics, communication and computing facilities;

Global Industrial Trends

Research and innovative solutions under development	IPID 2020	EU White Paper	Shift2Rail	US FRA Strategic Plan
Increased safety based on intelligent systems	☑	☑	☑	
Reduction of risks related to the human factor	☑			☑
Increased business efficiency and streamlining of logistics	☑	☑	☑	☑
Development of multimodal transportation	☑	☑	☑	
Harmonization of service-related requirements. “One stop"	☑	☑		
Development of virtual and cloud-based client services	☑	☑	☑	
Computerization and digitalization of traffic management processes	☑	☑	☑	☑
High-speed traffic development	☑	☑	☑	☑
New rolling stock	☑	☑	☑	☑
Increased energy efficiency	☑	☑	☑	☑
New powerplants. New types of energy resources	☑	☑	☑	☑
Focus on rational environmental management	☑	☑		
Infrastructure development	☑	☑		☑
Unmanned technologies	☑		☑	☑

Today’s Challenges. Tomorrow's Opportunities

Connectivity
Continuous connectivity will become critical differentiator between travel modes

IoT – Internet of Things
Connecting different objects to the internet opens a wide array of possibilities (e.g. sensors)

Big data
Big data and analytics capabilities provide different possibilities in both operational and sales aspects

Digital platforms
On-going engagement with customers and communities, e.g. through online platforms

Industry 4.0
Applying new tech tools to improve productivity

Autonomous driving
Autonomous driving trends with potential to change underlying costs structure

Cyber security
Mobility, as other industries, becoming a target for cyber attacks

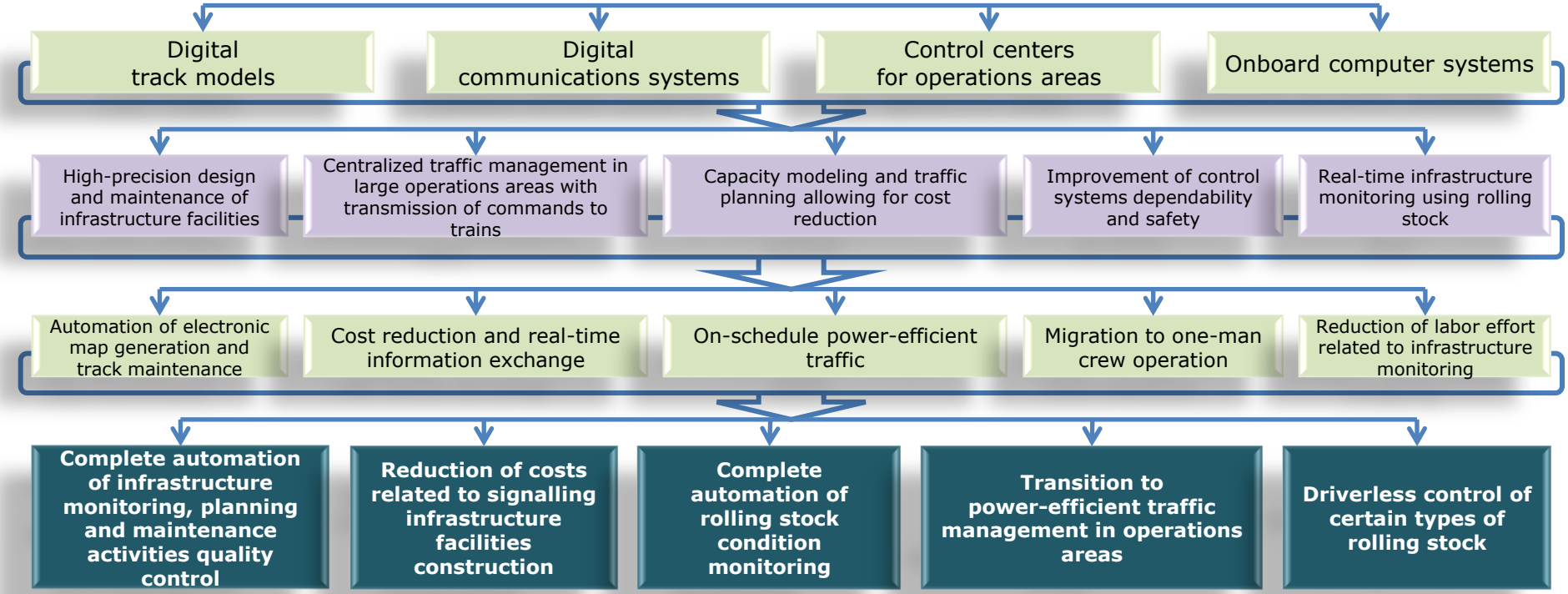
SHIFT²RAIL

European Commission · ALSTOM · AnsaldoSTS · BOMBARDIER · CAF · Network Rail · SIEMENS · THALES · TRAFIKVERKET

Main Prerequisites of Migration to Digital Railway

- Digital models of infrastructure assets in a common coordinate-temporal space
- Digital communication networks and high-precision coordinate systems based on high-precision satellite positioning networks
- Continuous monitoring of infrastructure assets with automatic generation of speed restrictions and organization of maintenance
- Rolling stock condition monitoring with external and internal facilities with the capability of predicting residual operating life
- Set of computing facilities for remote control of infrastructure assets, real-time modification of traffic schedules with regard to energy efficiency and automation of individual operations
- Mobile facilities of personnel location and psychophysiological state supervision

Digital Ways to Increase Traffic Efficiency



Asset Management in RZD (URRAN System)

OBJECTS OF TECHNICAL REGULATION

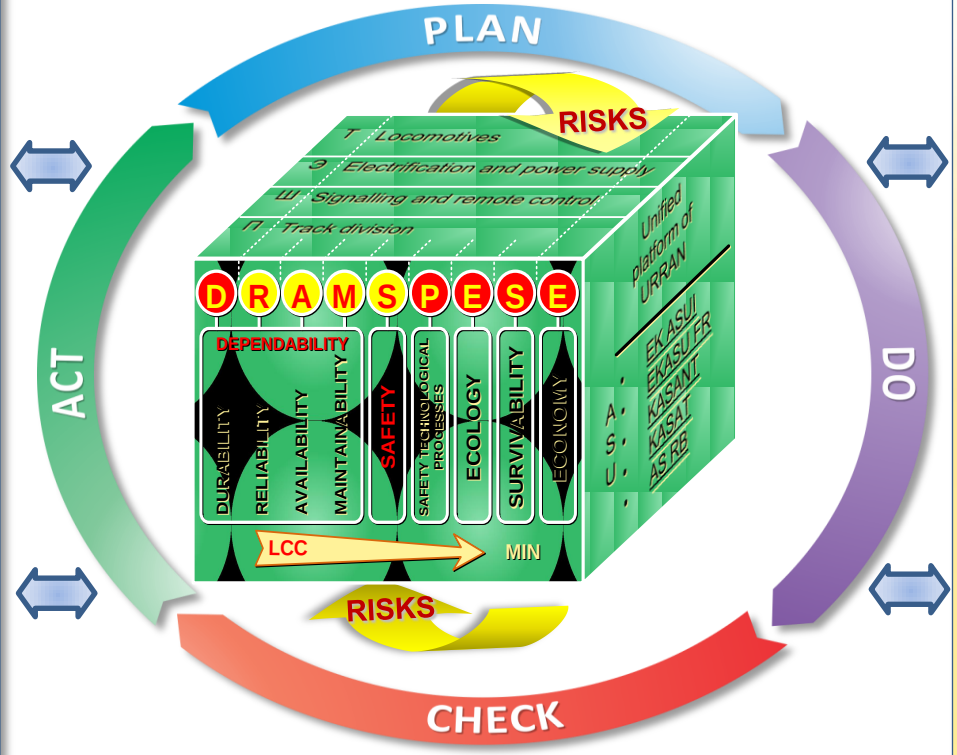
Track facilities

Electrification and power supply

Signalling and remote control

Telecommunication facilities

Fleet

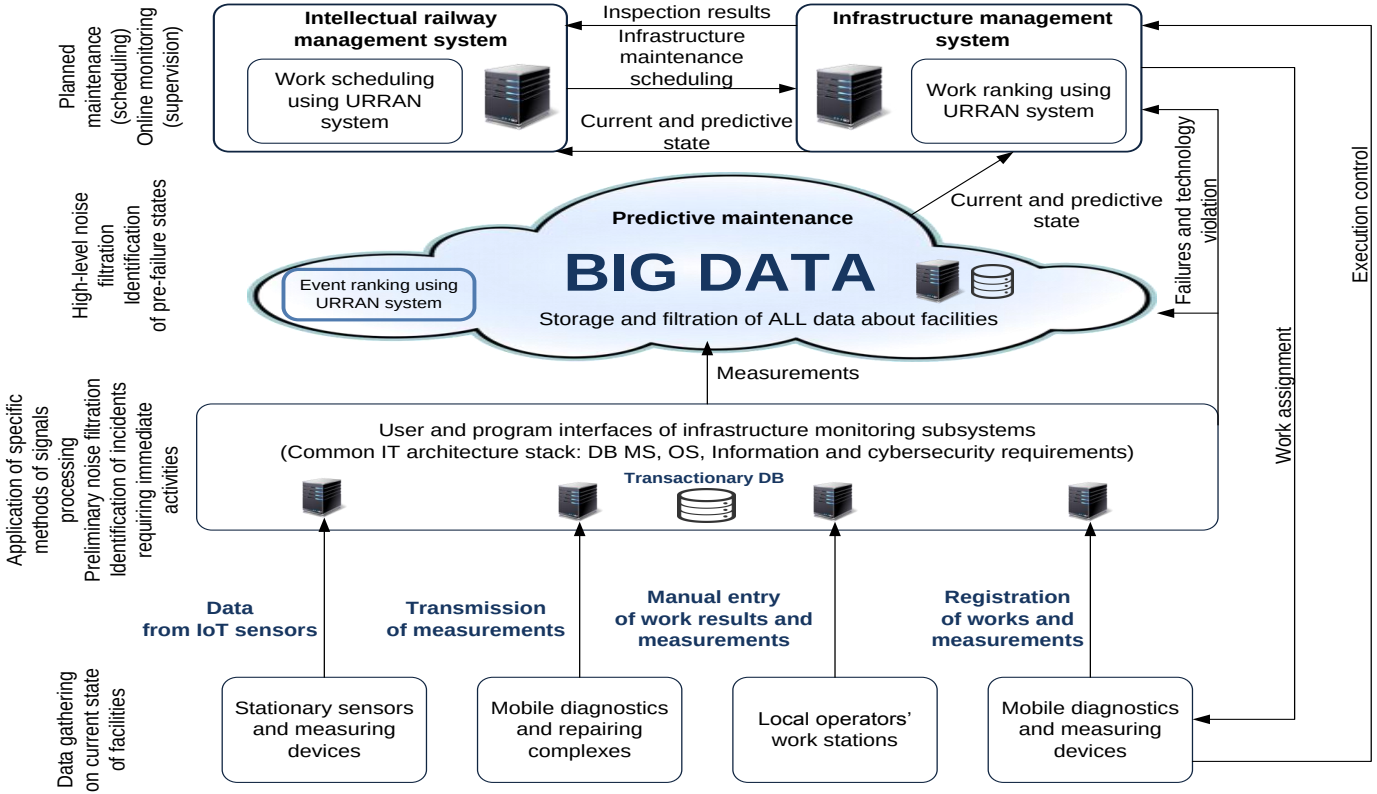


BASIC PROCESES OF RAILWAY TRANSPORT MAINTENANCE

- **Maintenance of infrastructure facilities and rolling stock**
- **Modernization of infrastructure and rolling stock**
- **Procurement management**
- **Management of environmental, fire, industrial and labor safety**

URRAN normative and methodological framework — over 125 documents

Integrated Asset Management System



Industrial Internet of Things

APPLICATIONS

Signalling | Rolling stock | Staff | Finance
Track | Power supply | Logistics | ...

IoT PLATFORM

Industrial automated control systems

Intellectual data analysis (URRAN, etc.)

RZD Data Centre (Main Computing Centre, Regional Computing Centres)

RZD SECURE NETWORK

DATA GATHERING MEDIUM

Gateways

WLAN (Wi-Fi, LoRa, Sigfox, RFID, etc.)

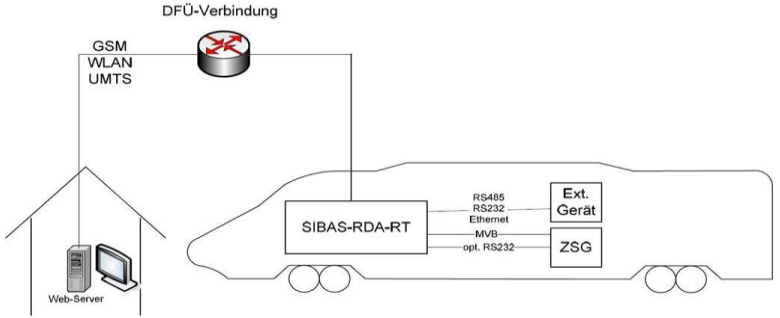
Sensors | Counters | Actuators | Data carriers | Data carrying devices | ...

CONNECTED DEVICES

IoT as Part of Industrial Cloud in Sapsan EMU

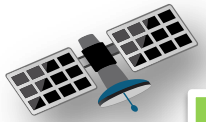
Diagnostics information is acquired from **900 sensors**.
The Central Control Unit (CCU) generates a diagnostics data package that is transmitted to the server via GSM. Transmission occurs once every 3 hours in automatic or manual mode.

Communication of diagnostics data to the X-Train web server



Diagnostics messages are assigned **"priorities"**. High-priority messages are to be treated at first convenience, lower-priority messages are planned for treatment when a train is submitted to routine maintenance. **The RRSD diagnostics data processing and communication system** complements the observations recorded in the TU-152 log and TU-28 maintenance book.

High-Precision Coordinate Network



GLONASS/GPS

Differential global navigation satellite system (DGNSS) GLONASS/GPS

Distance between base stations of DGNSS network is up to 50 km.

Digital Spatial Data

Network Center

Reference Network

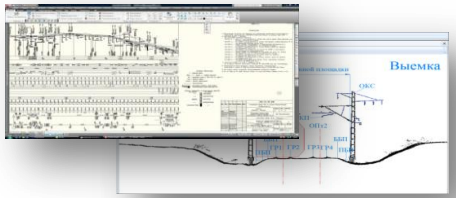
Distance between main points is up to 4-5 km.
Distance between intermediate points is up to 250-750 m.

Surveying

Network

Monitoring

Maintenance



Designing

Construction

Integrated Traffic Management

TMS level

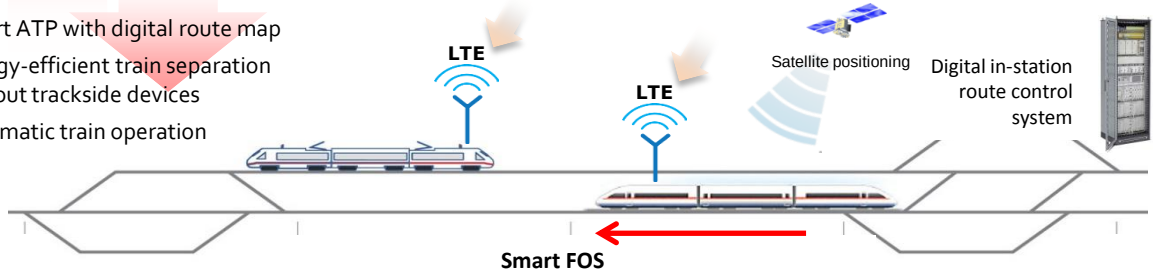
- Automatic traffic schedule execution
- Conflict identification and resolution
- Infrastructure and rolling stock monitoring

CTC level

- Automatic route setting
- Train control commands: acceleration and deceleration, emergency stop
- Diagnostics

Train separation and ATP/ATO level

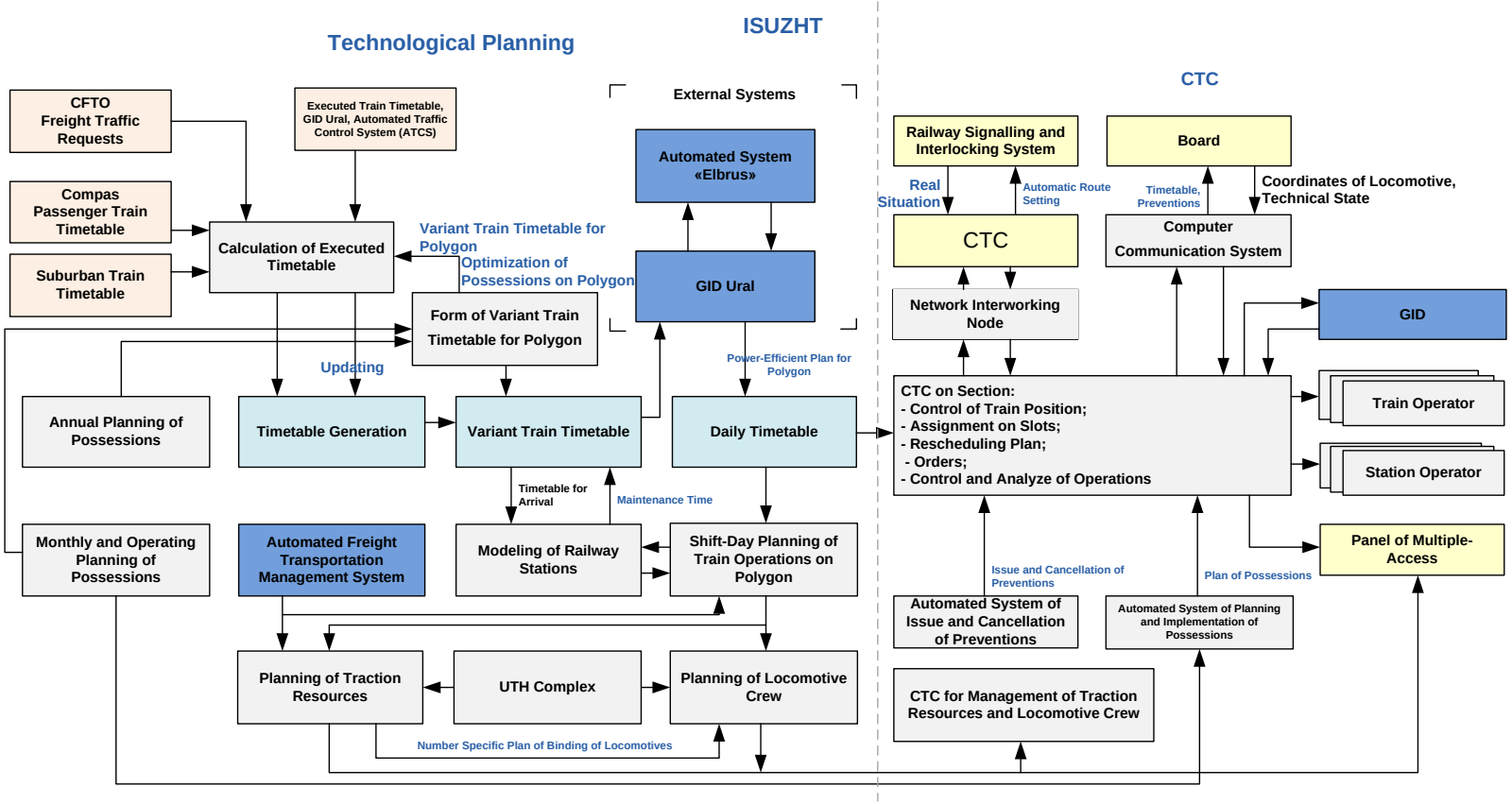
- Smart ATP with digital route map
- Energy-efficient train separation without trackside devices
- Automatic train operation



Common high-precision coordinate space
Multipurpose electronic maps with high-accuracy positioning system

Digital communications systems

ISUZHT Software Components



Digital Services for Passenger Transportation

TRIP PLANNING

TICKET PURCHASE

RAILROAD COMPLEX SERVICES

SERVICES ON BOARD

MULTIMODAL TRANSPORTATION

INNOVATIVE MOBILITY

Digital Services for Freight Transportation

FREIGHT

CONTRACT

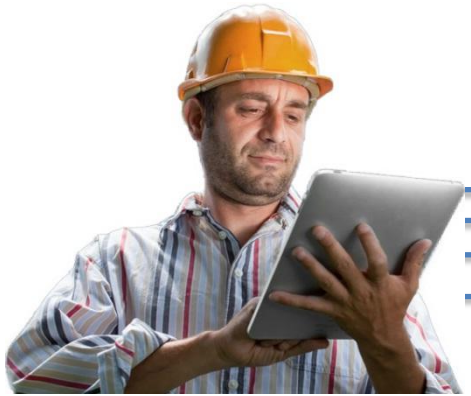
STORAGE

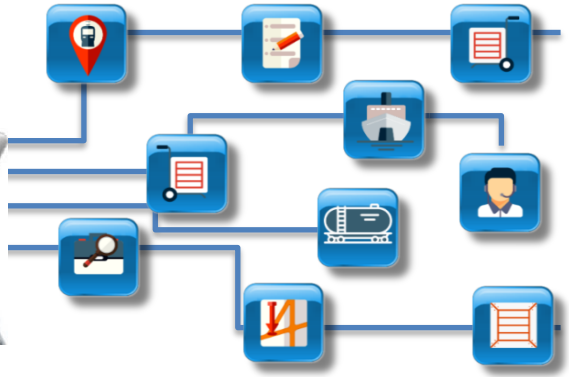
TRANSPORTATION

CUSTOM

MULTIMODAL TRANSPORTATION

DIGITAL SERVICES





Digital Railway for RZD Units

PREDICTIVE ANALYTICS

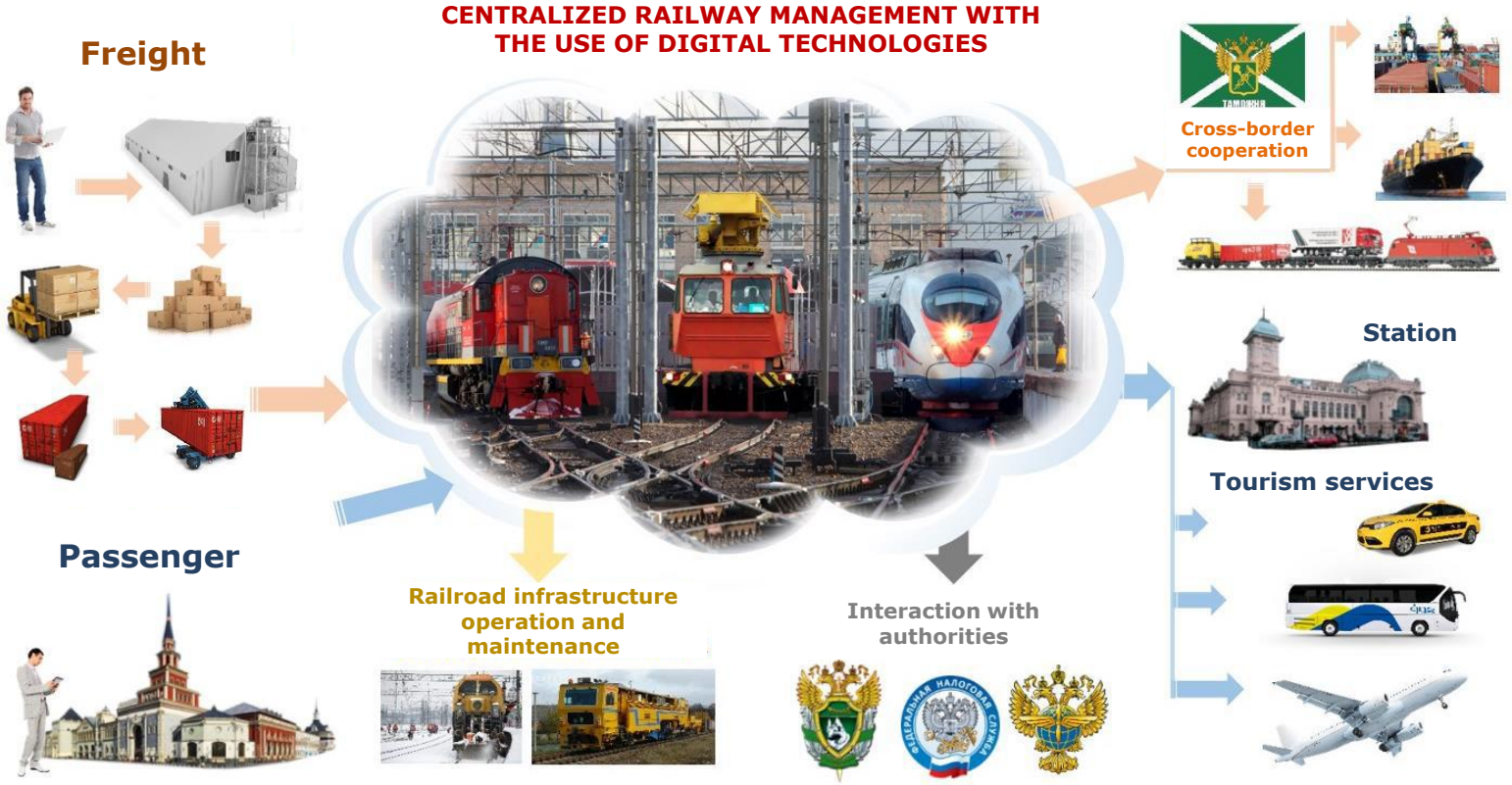
INFRASTRUCTURE MODELING

ONLINE CLIENT INTERACTION

PLM FOR INFRASTRUCTURE

INTELLIGENT SYSTEMS AND INFRASTRUCTURE

Digital Railway



Moscow Central Circle – “Moscow Digital Circle”

DPC
«Rolling stock»
«Big data»

CCU «Automatic train supervision»

DPC
«Infrastructure»
«Big data»

Infrastructure availability factor - 0,99

Rolling stock availability factor - 0,99

Rise in labor productivity in 2019 by 27% compared to 2016

Digital transport environment

GSM-R E-LTE

«Automatic driver»

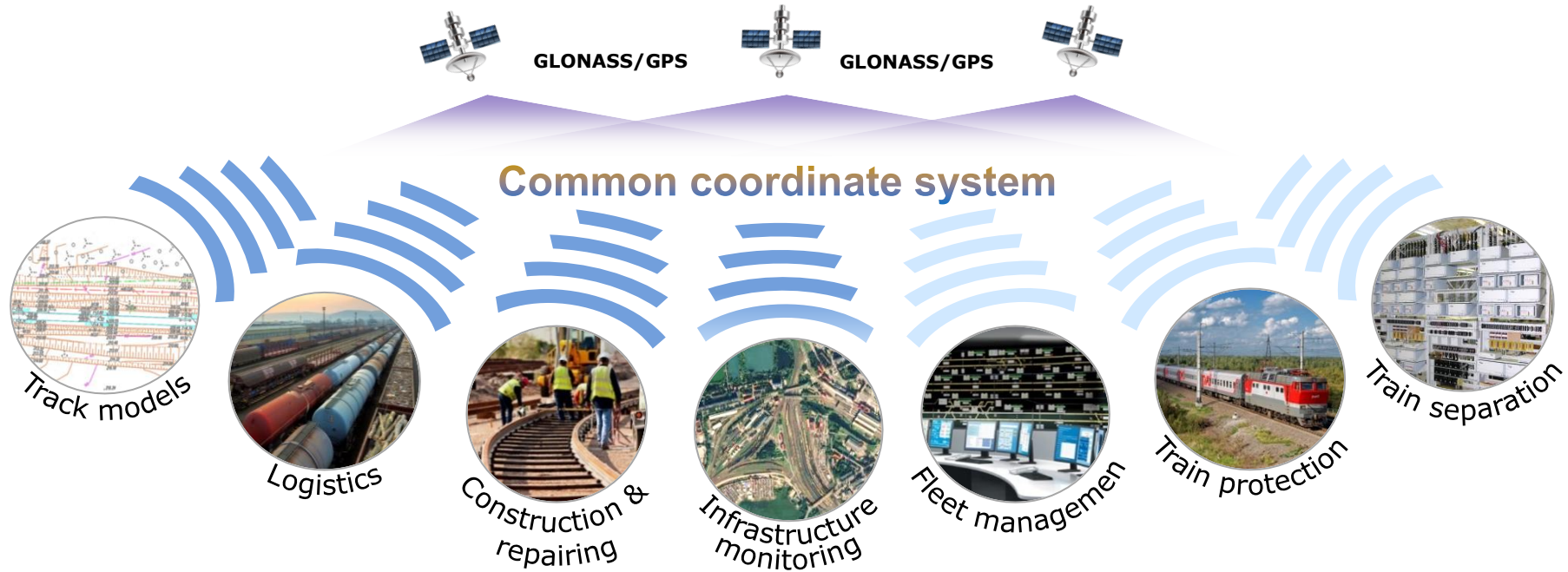
Embedded infrastructure diagnostic system

Embedded rail fault detection system

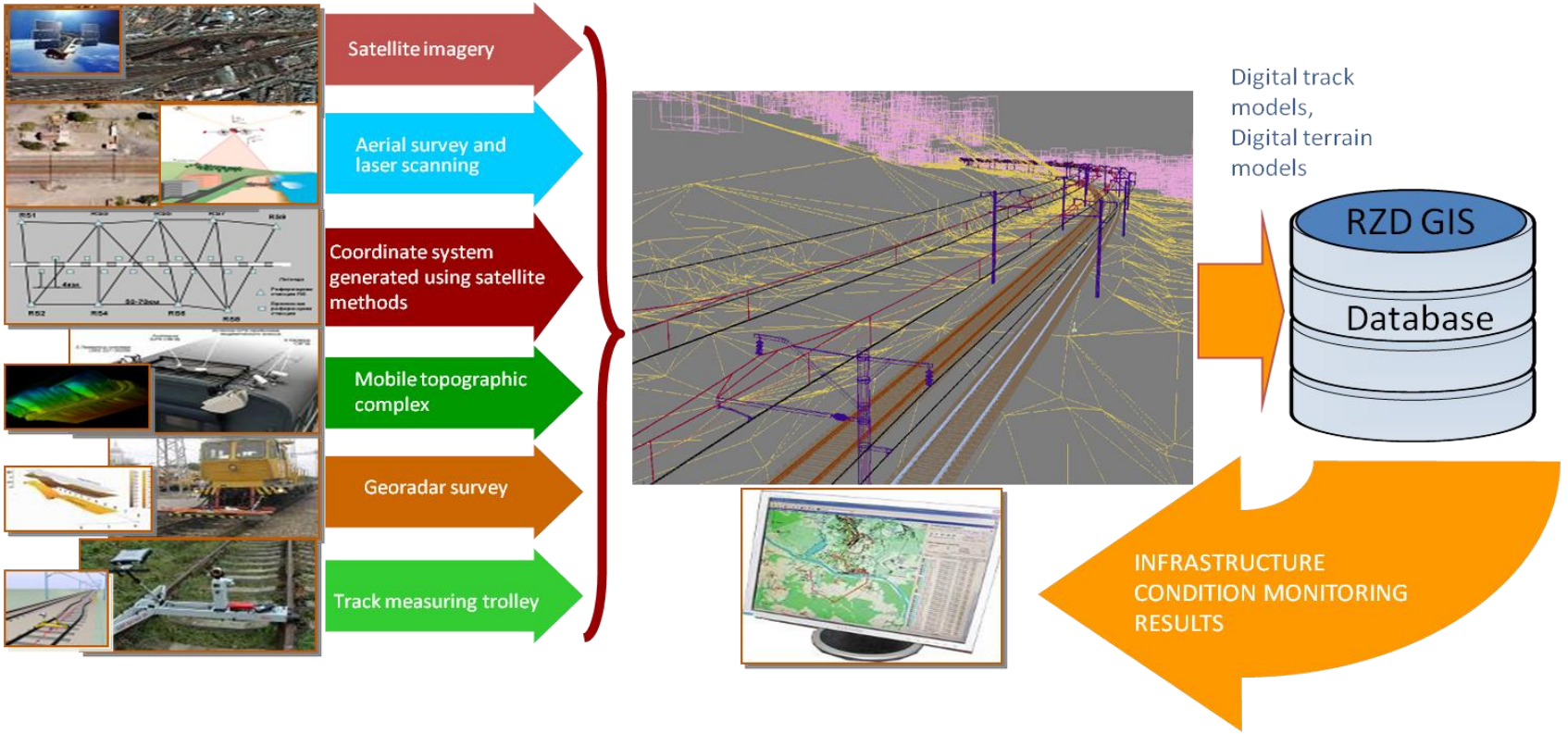
Passenger information

MORE TRAINS/FREIGHT/PASSENGERS. MORE CONNECTED. MORE CLIENT SERVICES.

Application of Satellite Technologies



Common Database for Digital Maps



ATO in Russia

ATO for commuter train

ATO for freight train

ATO for passenger long distance train

ATO for shunting train

ATO for high-speed train

Firstly, we are considering autonomous driving for shunting locomotives with special requirements

- *Standards IEC 62290, IEC 62267 define the requirements only for commuter trains (urban guided transport)*

ATO Targets in Russia

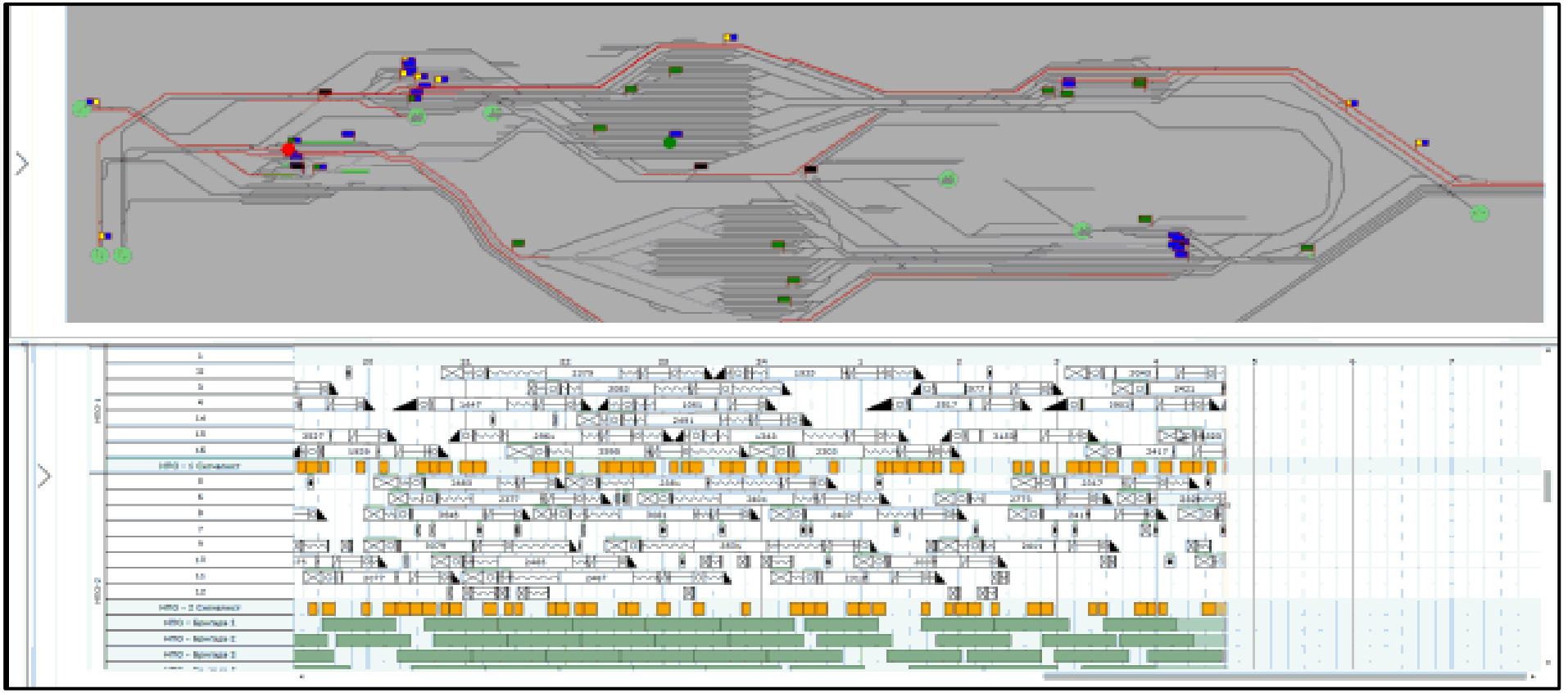
Train type	GoA
Commuter train	**3**
Freight train	2
Passenger long distance train	2
Shunting train	**4**
High-speed train	2

Analytical information about sorting stations work ДО-24ВЦ

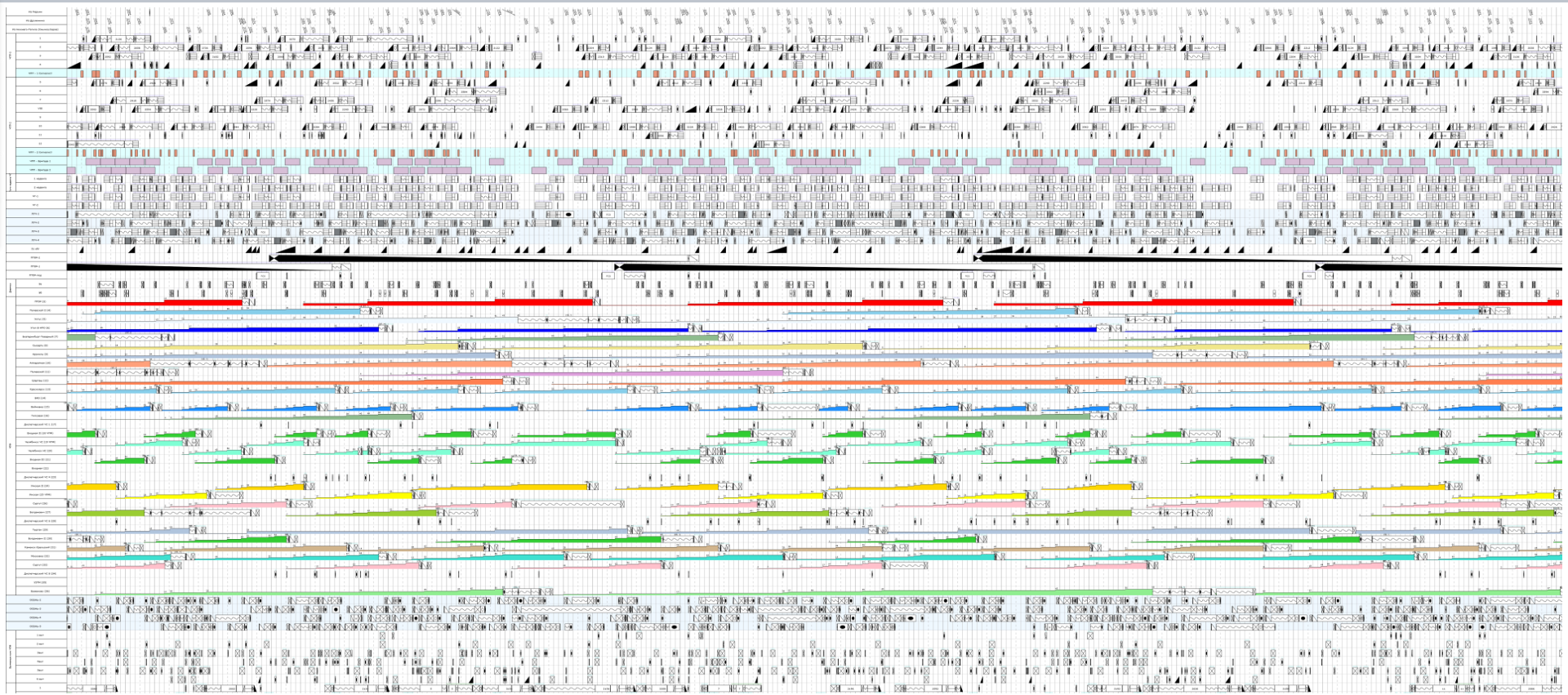
Month: May
Road: ОКТ
Stations: SPB-SORT-MOS
Arrived trains - 115
Sent trains
Total - 108
Including of its own formation - 103
Wagon turnover - 12367
Number of transit wagons
With sorting - 5892
Without sorting - 246
Working fleet of wagons - 4216
Number of wagons uncoupled from finished trains both of its own formation and transit
For technical problems - 0
For commercial problems - 1
Yard sorting of wagons
Even system - 3215
Odd system - 4203
Idle time of a transit wagon without sorting
Total - 2,42
Idle time of wagons in detained trains- 0,00
Idle time without wagons n detained trains - 2,42
Fastening and guarding of a train (Д) - 0,46
Technical preparation of a train (В) - 0,49
Waiting for processing - 0,06
Train processing - 0,43
Waiting for a locomotive (Т) - 0,59
Providing a train with brakes (Т, В) - 0,69
Waiting for departure (Д) - 0,20
Processing of a train for a transit wagon without sorting went through a guarantee area - 0,51
Idle time of a transit wagon with sorting
Total - 15,50
From arrival to start of division- 2,15
Fastening and guarding of a train (Д) - 0,44
Technical preparation of a train - 0,49
including waiting for processing - 0,17
including train processing - 0,32
Waiting for division (Д) - 1,22
Division (Д) - 0,29
Idle time in a marshalling yard (Д) - 7,85
Accumulation - 6,34
Waiting for formation (gauge changing) - 0,61
Formation and gauge changing - 0,89
Idle time of a transit wagon with sorting
Idle time from the end of train formation or its transfer to a departure yard before departure - 5,21
Fastening and guarding of a train (Д) - 0,59
Technical preparation of a train (В) - 0,80
Waiting for processing - 0,13
Train processing - 0,67
Waiting for a locomotive - 2,87
Providing a train with brakes - 0,71
Waiting for departure - 0,25
Delayed in approaches as not accepted
Trains - 0
Hours - 87
Number of canceled and derailed trains
Total - 0
through the fault of the service ДД - 87
through the fault of the service Т - 0
through the fault of the service В - 0
through the fault of the service Э - 0
through the fault of the service Ш - 0
through the fault of the service С - 0
through the fault of the service П - 0
through the fault of the service Л - 0
through the fault of the service М - 0
through the fault of the service НКИ - 0
through the fault of the service ИВЦ - 0
Trains unaccepted by neighboring roads - 0
Other reasons – 0

Luzhskaya Sorting Yard

ISUZHT TS Dynamic display of the calculation process

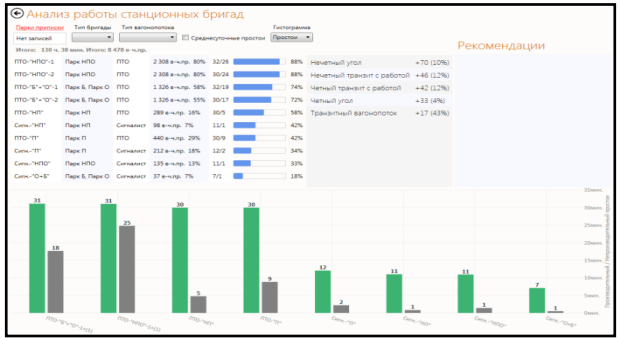


ISUZHT TS Visualization of the calculation process – the work schedule of the station

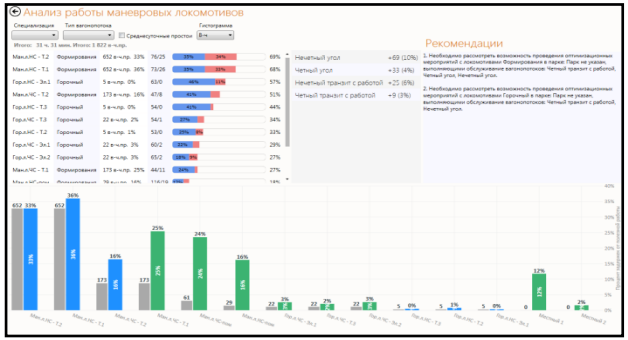


ISUZHT TS Analytical reporting

Station crews

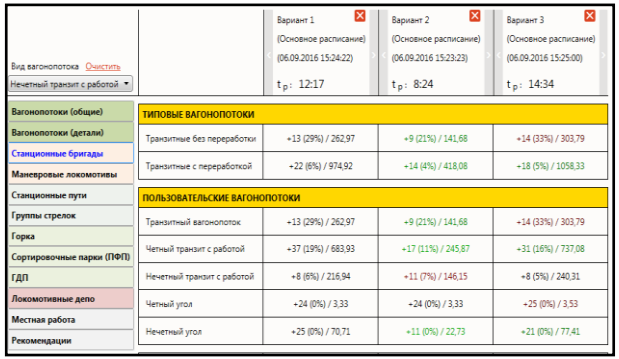


Shunting locomotives



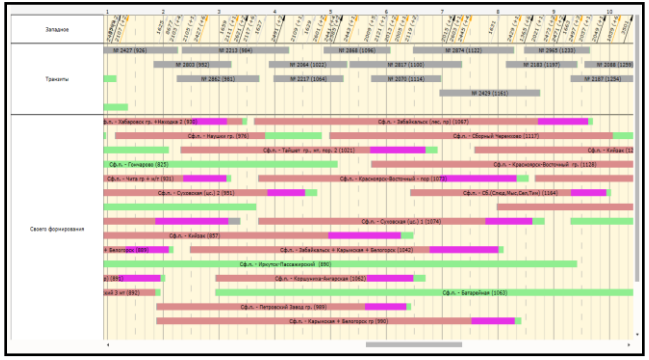
Wagons accumulation

Calculation options comparison



Idle time between operations

Trains departure



Thank you for your attention!