Digital Technologies for Railways

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Russian Railways

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

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

Digital Railway Architecture

CONTROL SYSTEMS ARCHITECTURE

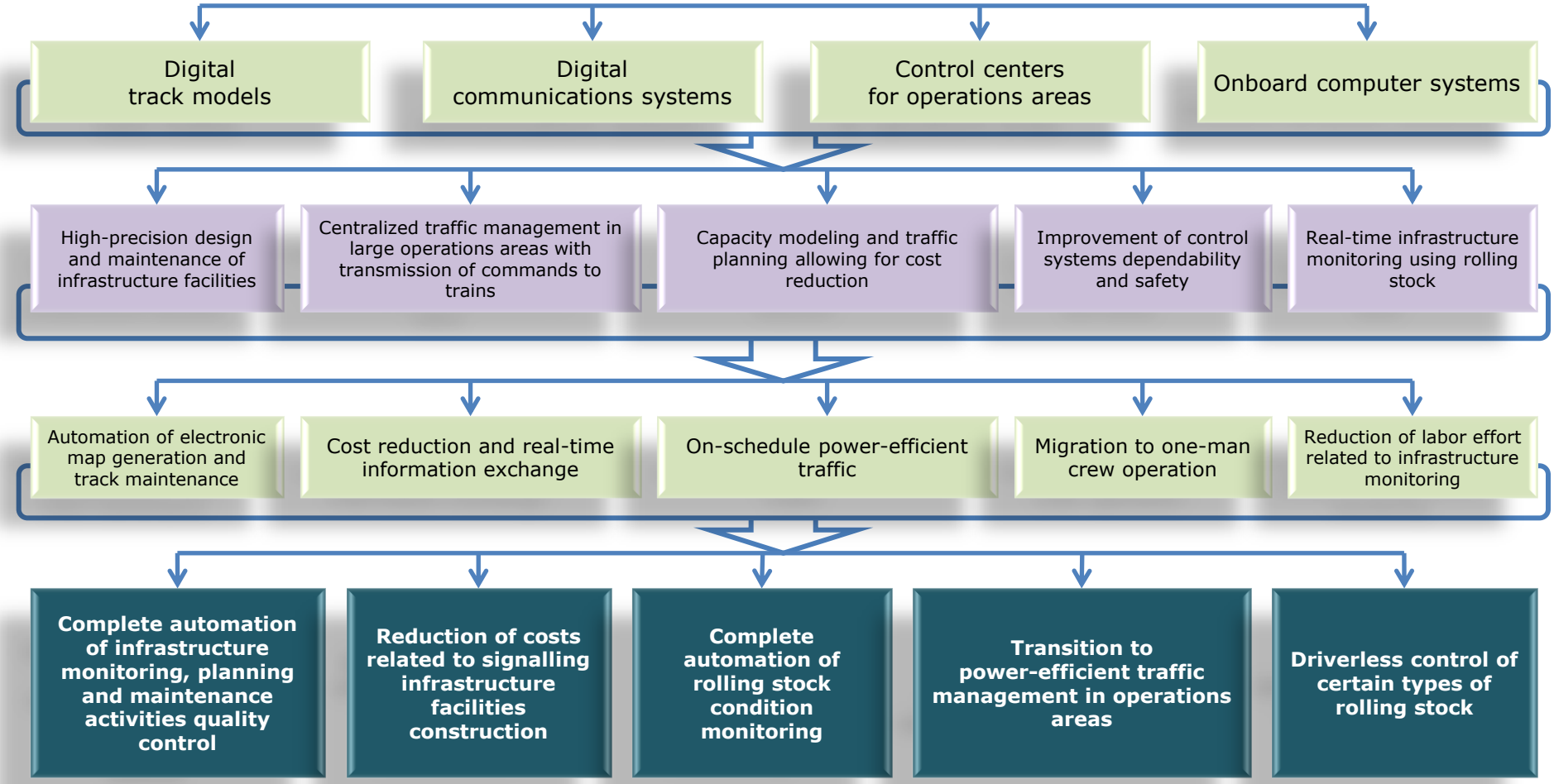
- Integrated process model
- RZD development strategy
- Key performance indicators
- Objective tree
- Consolidated service catalogue
- Organization structure.

PROCESS AND IT ARCHITECTURE

Holistic approach to systems integration:

- Single architecture management principles
- Standardized IT infrastructure
- General safety requirements.

Digital Ways to Increase Traffic Efficiency



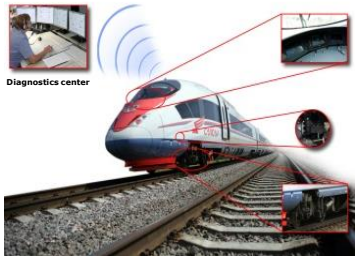
Integrated Traffic Management

Upper control level

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

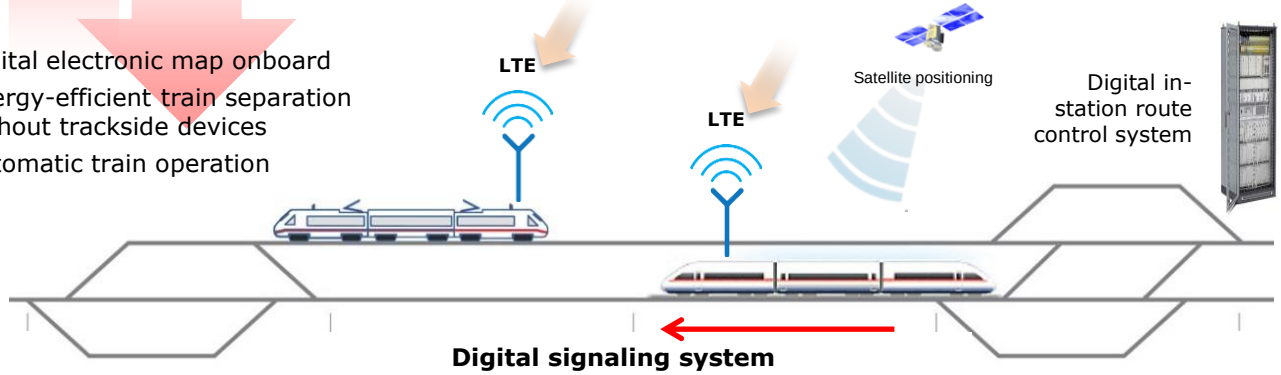
Centralized traffic control level

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



Train separation and automatic train operation level

- Digital electronic map onboard
- Energy-efficient train separation without trackside devices
- Automatic train operation



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

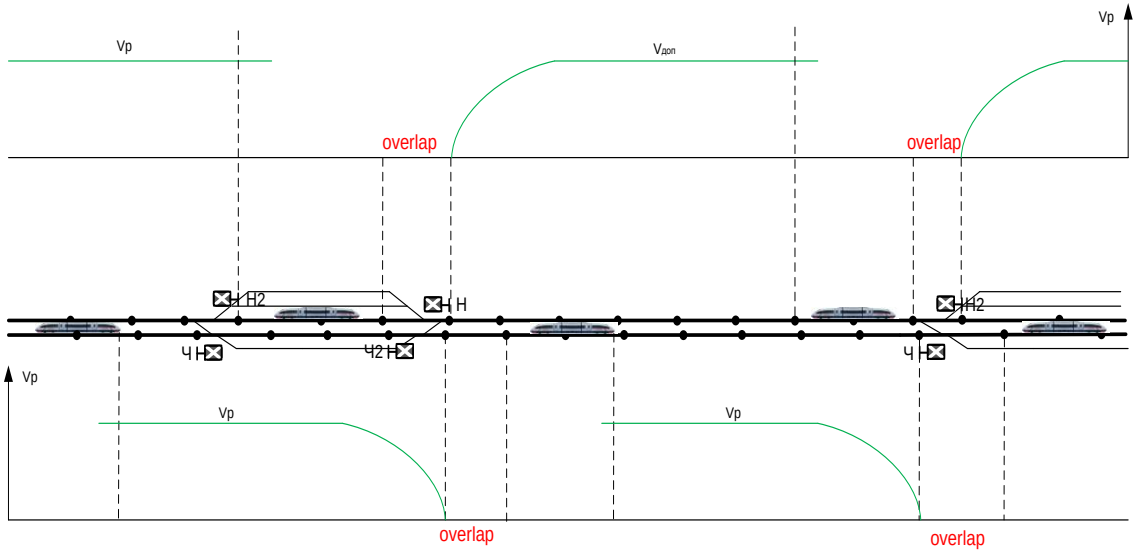
Digital communications systems

Moscow Central Circle

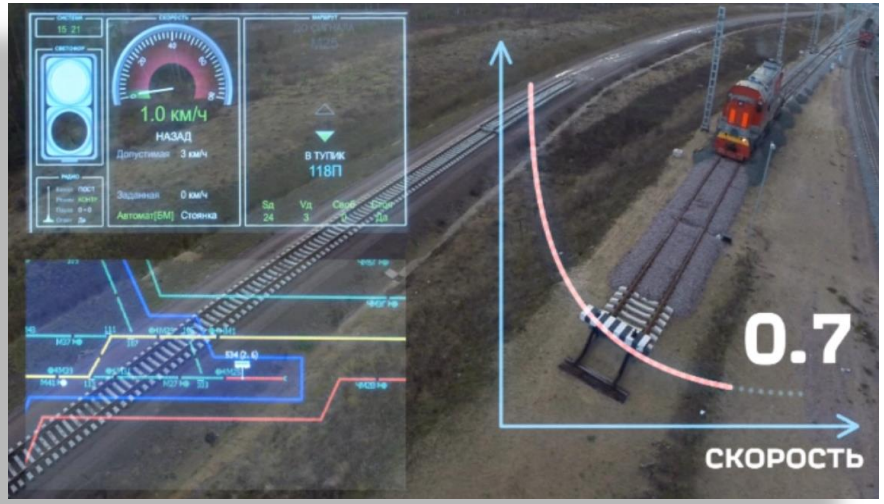
Russian Railways

Moscow Government

- Number of trains – 134 pairs a day
- Track length – 54 km
- Number of stations – 34 (including 17 transfer hubs)
- Headway – 3-5 minutes in peak hours
- Expected passenger flow – 250 mil a year.



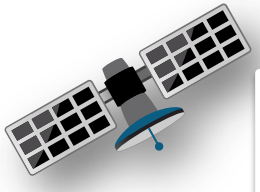
Automatic Management of Shunting Operations



- Automatic control of shunting engine's traction and braking systems
- Visual, sound and speech warning of driver on route and maximum allowed speed
- Emergency stop in case of roll-back, loss of communication between station-based and onboard systems, as well as upon station duty officer's command
- Logging of onboard and station-based equipment operation and personnel's actions
- Capability to move in automatic mode (without driver) and with no wagons coupled

- Automatic stop before a restrictive signal
- Supervision and control of shunting engine movement speed
- Communication with the shunting engine via a redundant radio channel
- Automatic positioning of shunting engine accurate within 1 m
- Assignment of shunting engine stop command and permission to pass restrictive signal using a workstation
- Integration with any type of power interlocking
- Capability to set routes through parts of a station equipped with different interlocking systems.

High-Precision Coordinate Network



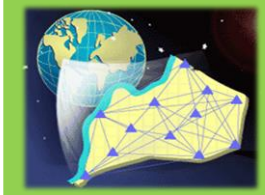
GLONASS/GPS

Digital Spatial Data

Differential global navigation satellite system (DGNSS) GLONASS/GPS

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

Network Center



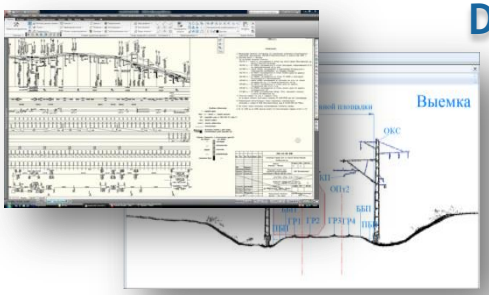
Reference Network

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

Monitoring

Surveying

Network

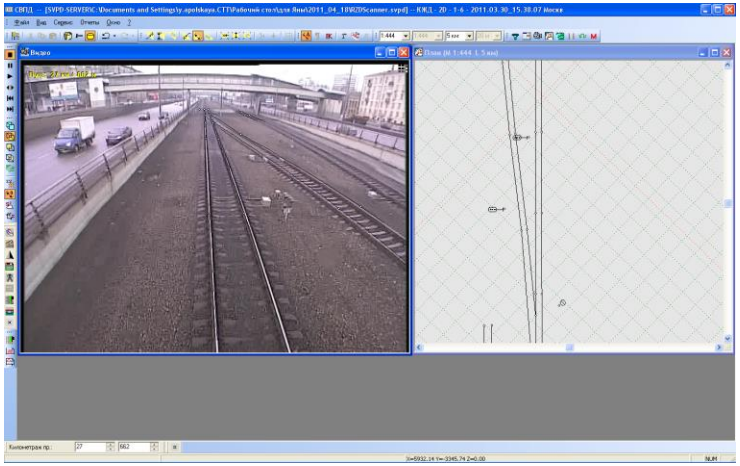


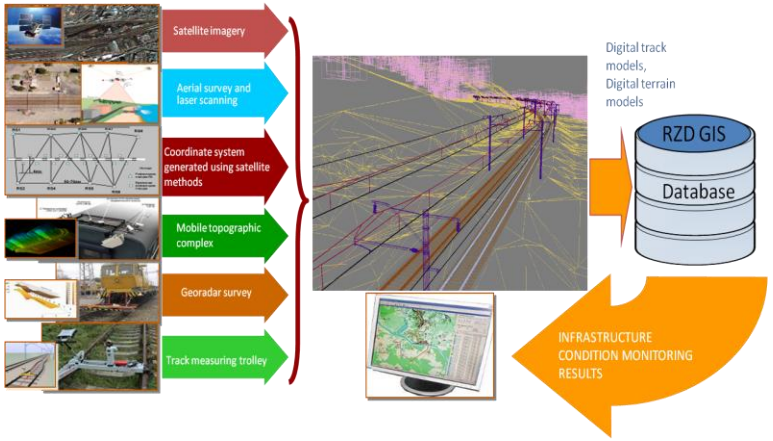
Designing

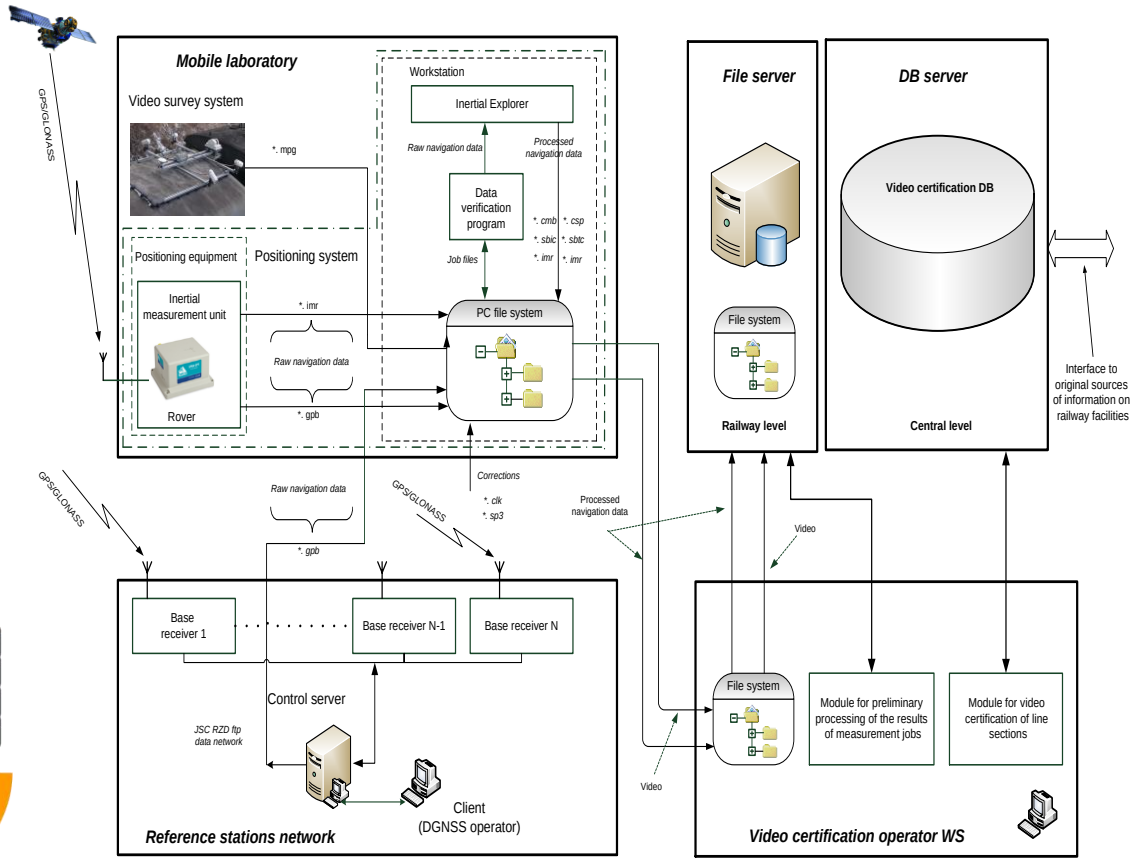
Maintenance

Construction

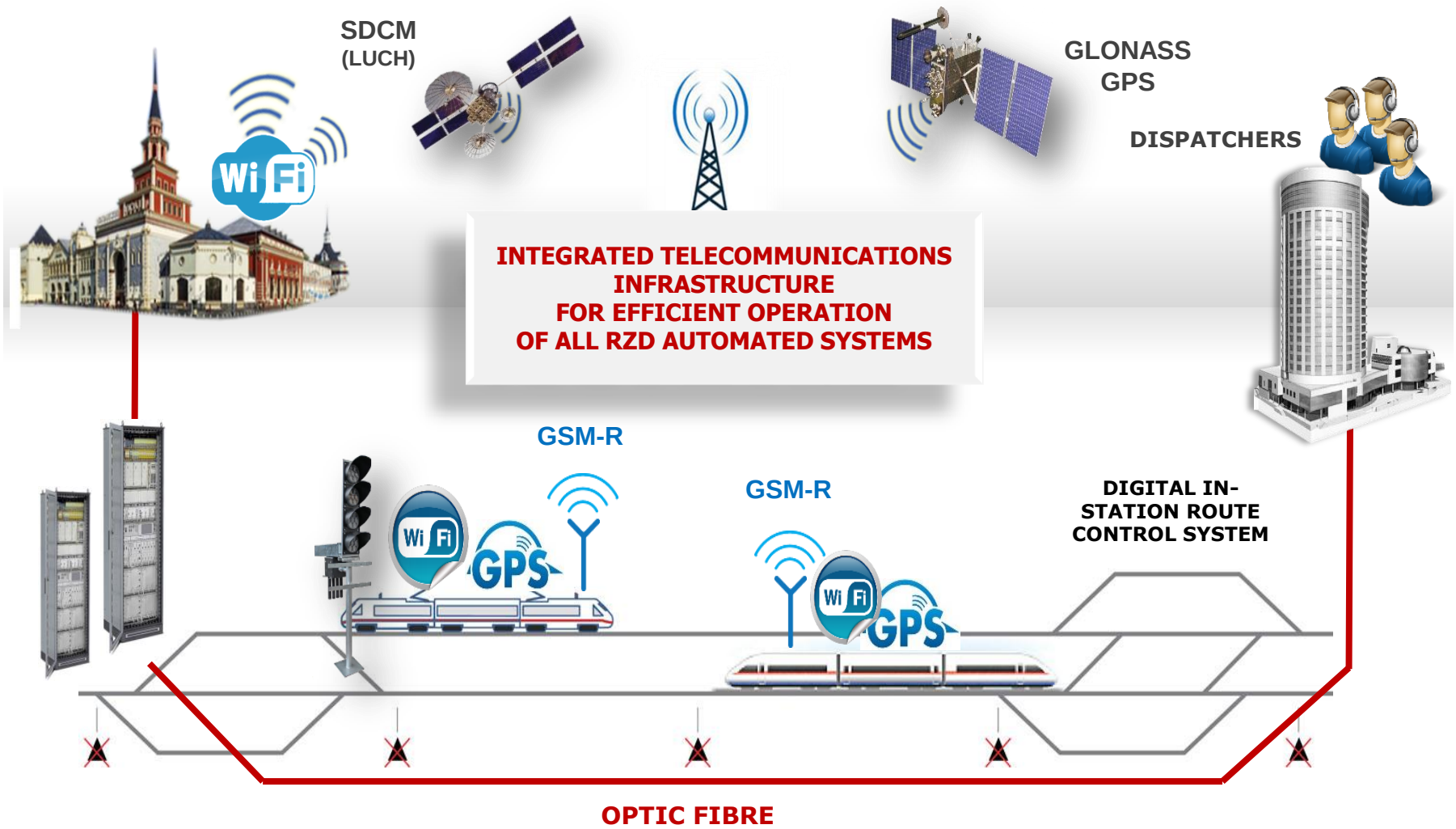
Common Database for Electronic Maps







Integrated Telecommunications



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

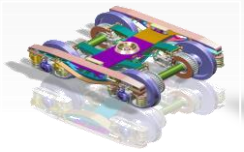
DATA GATHERING MEDIUM

Gateways

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

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

CONNECTED DEVICES



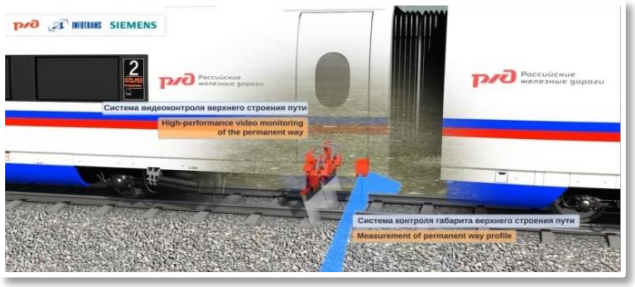


New Approaches to Diagnostics & Monitoring

System for catenary line geometry control

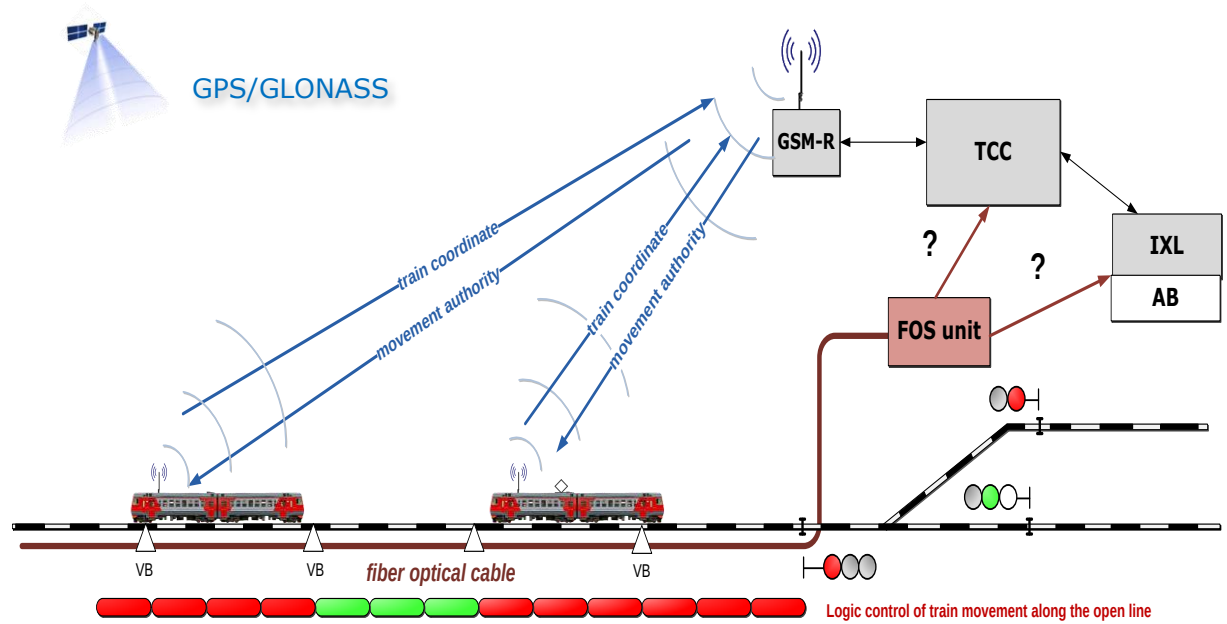
- diagnostic equipment is installed on existing rolling stock with no intrusion into the standard onboard equipment
- diagnostics activities do not interfere with the traffic process, while insuring high frequency of high-speed lines condition monitoring
- condition diagnostics are performed without interrupting the operation of high-speed rolling stock, track infrastructure and catenary line
- complete automation of all control of diagnostics equipment, measurements, processing and evaluation not requiring the presence of an operator

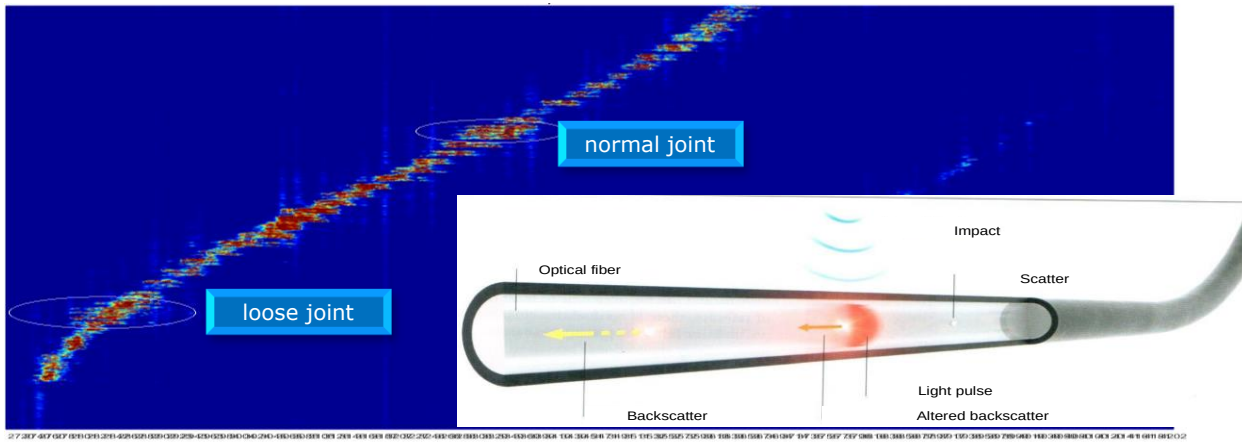
Multifunctional inertial non-contact measurement system



System for superstructure dimensions control

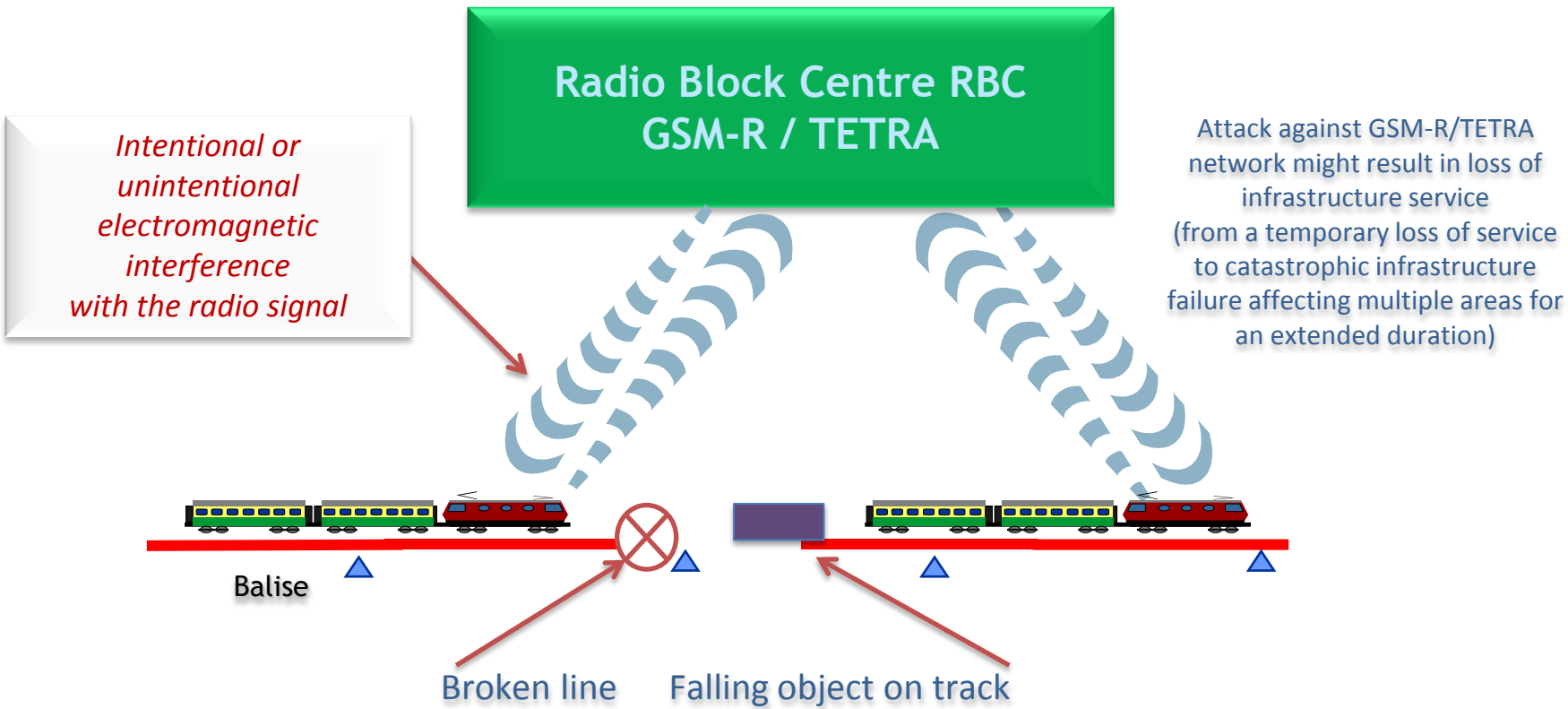
New Potential Solutions Based on Optical Fiber





- Distributed sensing system for generating warning signals to level crossing protection systems, PIS/PAS, hot box detection posts, etc.
- Identification of a train category (freight, passenger, single loco, trolley, etc.)
- Identification of axle parameters (flat wheel, hot boxes)
- Sensing of rolling stock derailment
- Identification of cars with vibration (modulation) higher than standard one
- Check for efficiency of track lubrication through a sound profile of curve passing
- Detection of violations related to fixing of track elements such as screws on joint fishplates, choker bridges etc., track box caps, trackside cabinet doors etc.
- Control of alien objects falling down on track (trees, stones, lamp masts, etc.)

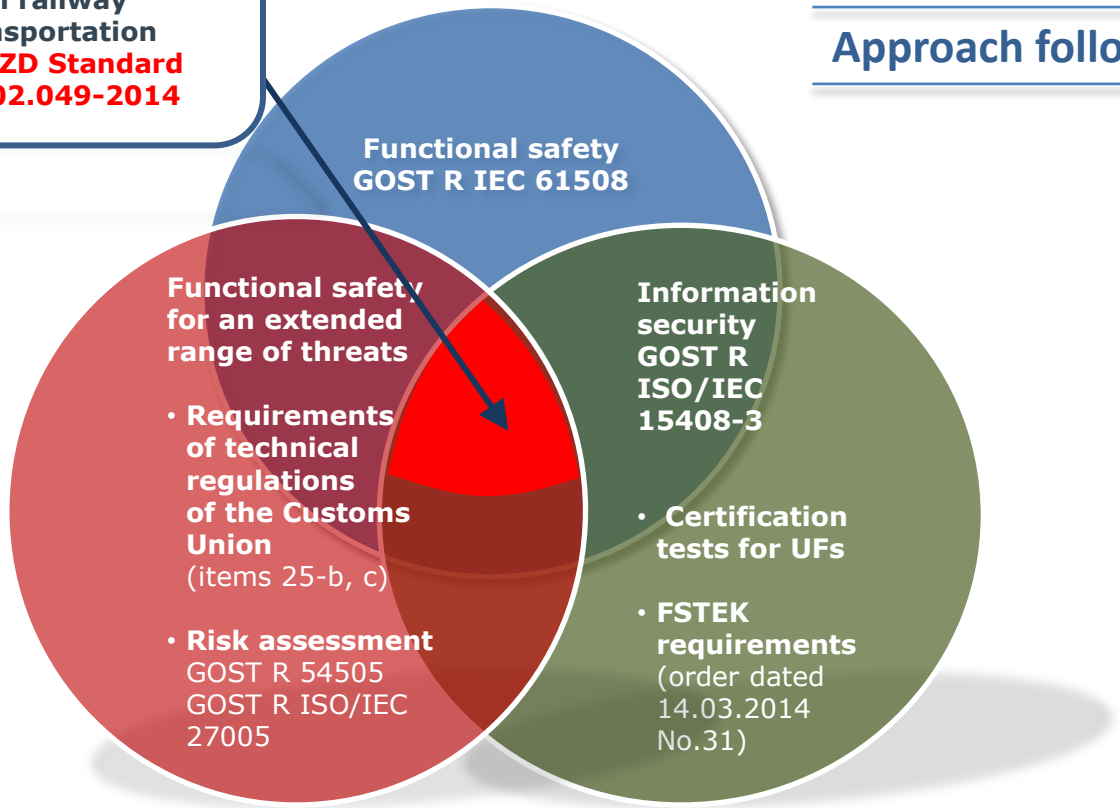
Threats and Hazards for Train Safety



due to occasional or malicious events

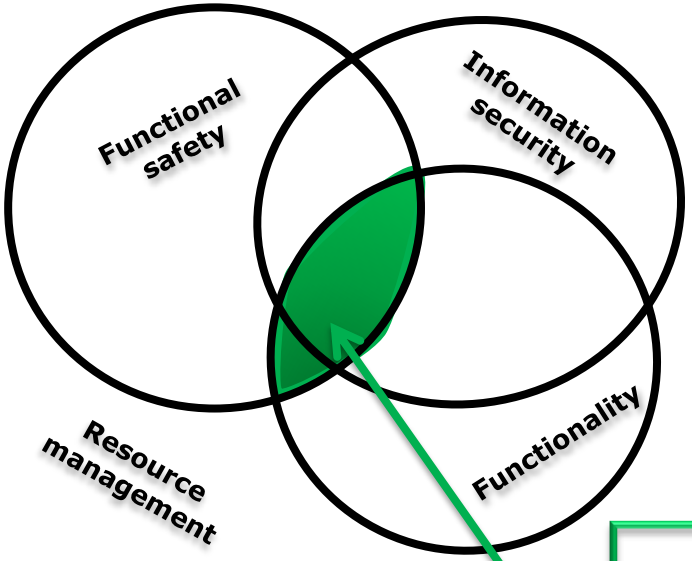
Cybersecurity of Digital Railways

Cybersecurity APCS hardware and software in railway transportation
JSC RZD Standard STO 02.049-2014



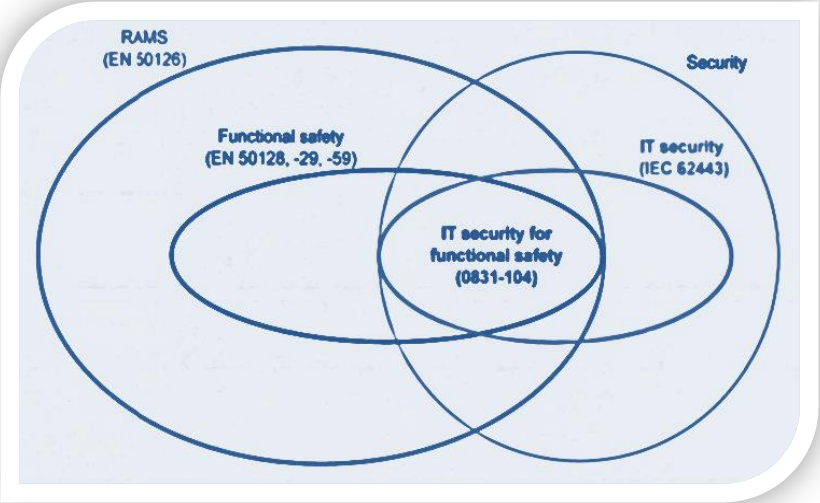
Approach followed by Russian Railways

Cybersecurity of Digital Railways



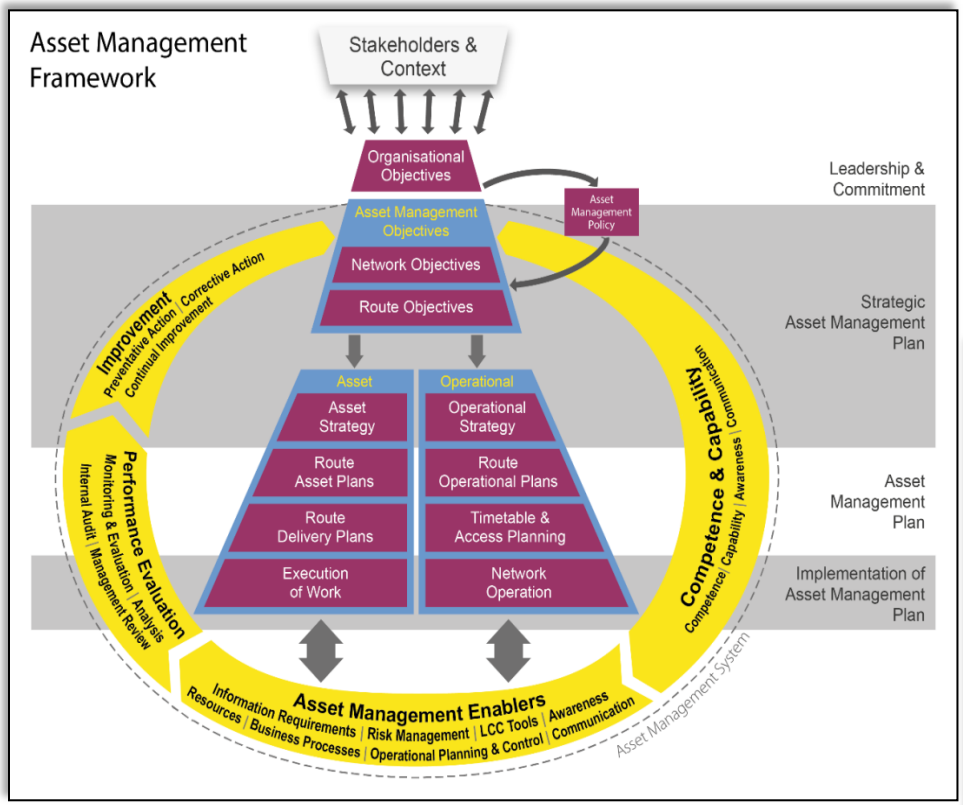
Compromise between system safety and its operating costs is achieved or not achieved at the first stage of system design

UIC ARGUS project

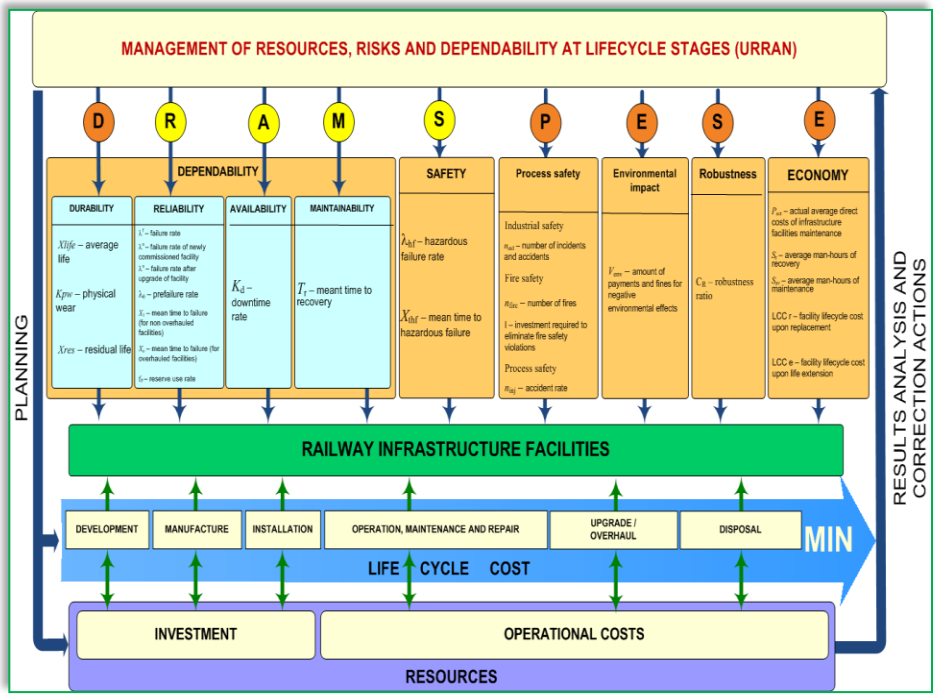


European approach

Asset Management



URRAN System



UIC ISO 55000 Guidelines Document
ISO 55001 Implementation Guidelines
for Railway Infrastructure Organisations

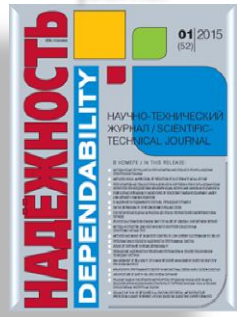
Asset Management in URRAN System

Facility	Goals
Track facilities	Reduction of lifecycle cost of track facilities through redistribution of resources while ensuring the required level of operational dependability and allowed level of train traffic safety
Automation and remote control	Improvement of operational dependability of railway automation and remote control devices while ensuring allowed (required) level of train traffic safety based on optimization of resource management and lifecycle cost
Electrification and power supply	Extension of the lifecycle of power supply facilities based on risk evaluation while ensuring the required level of operational dependability and allowed level of train traffic safety
Motive power facilities	Reduction of lifecycle cost of locomotives through more efficient resource management while ensuring the required level of operational dependability and allowed level of train traffic safety
Central Directorate for Multiple Unit Rolling Stock	Reduction of lifecycle cost of MURS through efficient resource distribution while ensuring the allowed level of train traffic safety and passenger comfort.
Communications	Reduction of lifecycle cost of railway telecommunications systems through more efficient resource management based on improved telecommunications networks operation procedures while ensuring required safety and dependability of telecommunications services.

Document	Quantity, units
International standard (GOST)	2
National standard (GOST R)	6
JSC RZD standard (STO RZD)	19
Method	67
Recommended practices	8
Guidelines	1
Classifier	12
Norms	4
Classifier and norms	1

URRAN Coverage

Publications in Russian and English in the Dependability journal



Over 30 publications in several languages in a number of countries in 2012-2016.

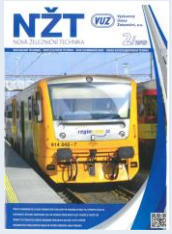
- Austria, Armenia, Germany, China, Romania, Slovakia, USA, Switzerland, Czech Republic, etc.
- EI, Eisenbahn Österreich, Schweizer Eisenbahn Revue, NŽT, RailwayPRO, Reliability: Theory & Applications, Signal+Draht, etc.

Presentations in prominent international conferences and railway forums

- InnoTrans 2012, 2014
- Standardization and Technical Regulations in the New Environment (Almaty, Kazakhstan, October 28-29, 2014)
- International symposium Probabilistic Models in Dependability Technology and Industrial Process Control
- Meetings of the UIC Asset Management Working Group in 2015-2016 (Paris, Rome, Oslo, Dublin)

RailwayPRO (Romania)

02/2015



VUZ Nova Zeleznicni Technika (Czech Republic)

02/2015

Schweizer Eisenbahn Revue (Switzerland)

12/2015

Schweizer Eisenbahn Revue (Switzerland)

01/2016

"URRAN" – Entwicklung von RAMS bei den russischen Eisenbahnen

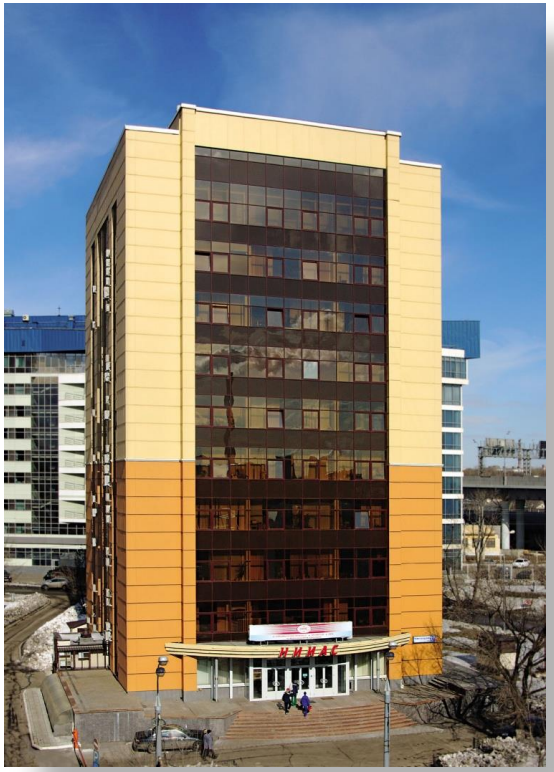
01/2014

Harmonization of single approaches to the methods of resource, risks and dependability management as part of working meetings

DB adif ÖBB SNCF

JSC NIIAS

UIC Affiliate Member



Thank you.

Questions?

www.vniias.ru