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MODERNIZATION OF OKTYABRSKAYA RAILWAY (MOSCOW - ST. PETERSBURG - HELSINKI) AS A SHOWCASE OF IMPROVEMENT OF THE TRANSPORT AND LOGISTICS INFRASTRUCTURE ON THE RUSSIAN RAILWAYS

Abstract

The article covers the issues of the modernization of Oktyabrskaya Railway (Moscow - St. Petersburg - Helsinki) aimed at the improvement of transport and logistics infrastructure of the Russian railways. In this regard, the introduction of the following technologies was analyzed: traffic control system ALS 400, global data transmission system GSM-R Track – Train, and the upgrading of track with continuous welded rails, Pantrol-350 anchor rail fasteners for high speed railway, and point switch system retrofit.

The organization of fast and relatively inexpensive transit railway corridors between the European Union and China has been occupying the minds of scientists and experts for over a decade. One of the corridor route options is the Trans-Siberian Railway (Vladivostok - Khabarovsk - Chita - Irkutsk - Krasnoyarsk - Novosibirsk - Yekaterinburg - Nizhny Novgorod - Moscow - Minsk - Brest - Warsaw). However, the track infrastructure on this route is in serious need of retrofit, including control system compatibility with the European ERTMS (European Rail Traffic Management System) standard. This article addresses the modernization practice of Russian Railways (RZD) aimed at ensuring the compliance of public rail lines (high speed, freight and passenger service) with the European railway standards illustrated by Oktyabrskaya Railway case study.

By Russian standards, Oktyabrskaya Railway (OZD) is a unique example of a common railway infrastructure that provides a regular equal-headway operation of high speed rolling stock Siemens Velaro RUS (“Sapsan”) (Moscow - St. Petersburg route) and Alstom Pendolino (Sm6 “Allegro”) (St. Petersburg – Helsinki route) as well as high-speed regional expresses Siemens Desiro (“Lastochka”) (routes Moscow – Tver, St. Petersburg – Bologoe, St Petersburg – Vyborg), etc. At the same time, these very lines ensure the regular traffic of both long distance trains (approximately 60 trains per day on route Moscow - St. Petersburg – Moscow alone, including enhanced comfort double-decker night trains 61-4465 produced by Tver Carriage Works), and suburban EMUs ET2M manufactured by Torzhok Wagon Repair Plant.

From the day it was constructed till now, the main OZD section St. Petersburg – Moscow is one of the densest lines in Russia. In 2015, the carriers that operate on it transported 122.1 million commuters and 20.7 million long distance travellers. In fact, despite the economic downturn and road and air transport competition, there has been only a minor passenger flow reduction recently. For instance, in 2011 the number of OZD passengers exceeded 134 million 183 thousand people, with 118.6 million passengers on commuter lines and 17 million passengers on long distance lines. At the same time, the number of passengers’ interest in high-speed transport grows more and more. For only 9 months of 2016 over 3.5 million people travelled on high speed trains Sapsan, which is 33.5% more than over the same period of 2015. Since the beginning of Sapsan operation, over 21.5 million passengers have been carried.

OZD freight volume has been growing continuously with 218.3 million tons in 2009 and 260.7 million tons in 2015. However, these numbers mainly refer to Leningrad Region and its port infrastructure since at the moment the freight service is not performed on Moscow - St. Petersburg section, but on the latitudinal lines of Savelovskoe section (Valdai - Sonkovo, Velikie Luki - Shakhovskaya, Shakhovskaya - Rzhev and some other sections). As to the classification of goods, in September 2016, the following cargo was shipped on Oktyabrskaya Railway: 2.4 million tons of iron ore (+ 23.2% by September 2015); 88.1 thousand tons of cement (+ 26.4%); 398.1 thousand tons of timber (+ 4%); 723 thousand tons of oil and oil products (+ 5.9%); 1.3 million tons of fertilizers (+ 16.7%); 100 tons of chemicals (+ 87.3%).

These results could not have been achieved without significant investment into the upgrading of the existing railway infrastructure. For example, the renovation of railcar depot St. Petersburg - Moscow (TCh-10) – essential for Sapsan maintenance – alone cost RZD over 2 billion RUR; or, for instance, the contract between Russian Railways and Siemens for the joint production of Velaro RUS trains is estimated at € 1,5 Bln.

However, the most interesting system in terms of sharing OZD retrofit experience for future Russian railway infrastructure modernization (including the Trans-Siberian Railway) is ALS 400. Combining the best features of the existing KLUB-U/ BLOCK systems operating on the Russian railways, this system is both fully compatible with ERTMS and considerably improved for the adaptation to the Russian conditions.

ERTMS standards and technologies customized for operation in Russia:

- the system can be both installed on dedicated high speed lines and used for extending automatics and telemechanics (ZhAT) systems on the existing lines;
- improvement of the automatic locomotive signaling (ALS) efficiency due to the integration of Russian KLUB-U technologies;
- GLONASS for train positioning;
- interface with BLOCK for ALSN mode (on the general tack and for redundancy);
- ALS 400 compatibility with the existing ZhAT used on Russian railways;
- use of high reliability hardware and software proven in work within ERTMS on high speed lines worldwide;
- support of various modes and levels of operation;
- highest level of high speed traffic safety due to the high level of automation and agreed concept of integrated safety.

This article will be confined to the general description of ALS 400 operation in the form of a scheme (Fig.1).

General architecture of interaction between the automatic control system and automatic locomotive operation system is as follows (Fig.2):

1. The train forwards the arrival event to the control center;
2. The control center sends the departure time to the train;
3. The train forwards the departure event to the control center;
4. Automatic control center calculates optimal travel time;
5. The automatic operation system calculates the optimal time-distance curve;
6. The automatic operation system runs the train following the calculated speed profile.

Some of ALS 400 components, however, are used not only for OZD but other rail mainlines as well. For instance, in 2014-2016 in Moscow Region, a global data transmission system GSM-R Track Train was deployed. It connected Oktyabrskaya, Moskovskaya, Gorkovskaya, and South Eastern Railways into one network. The general network scheme is presented on Figure 3.

Nevertheless, it is well-known that the safety and efficiency of any transport system is not limited to special technologies that ensure traffic security. The reliability of the operated railway infrastructure is crucial as well, since no automatic system can safeguard against issues caused, say, by a catenary break or a wheel/rail disturbance.

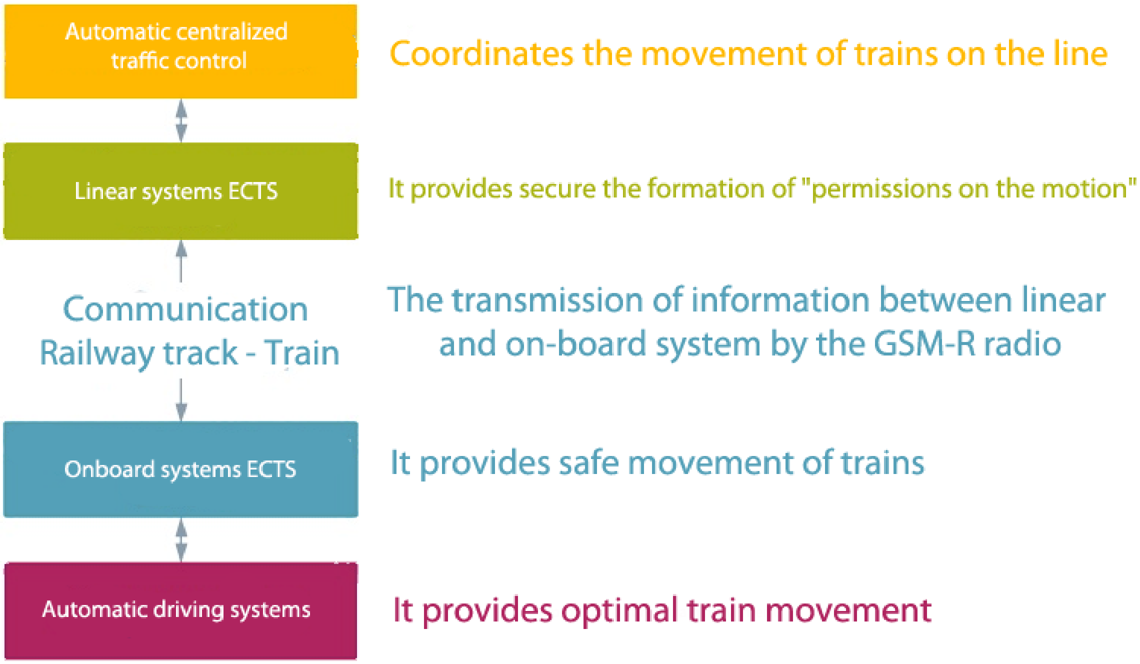

Fig. 1.*Concept of automatic traffic control [1]*

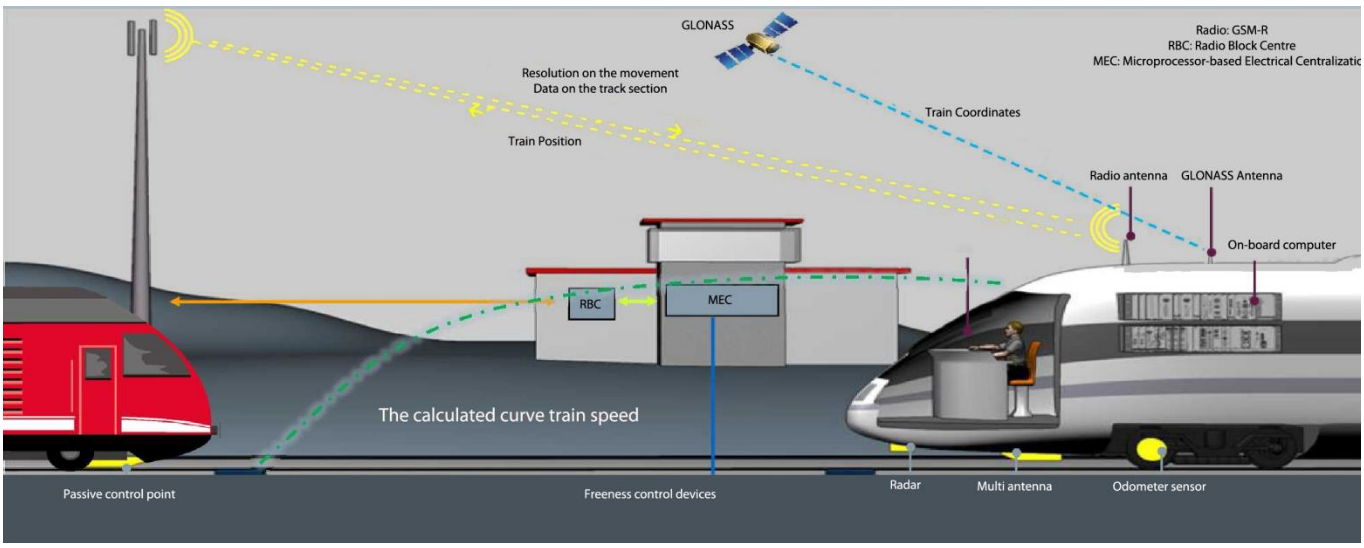

Fig. 2.*General scheme of ALS 400 operation on public track [1]*

With that in mind we shall make a brief overview of solutions and technical complexes used for the modernization of the existing transport infrastructure.

The following solutions and equipment are used to retrofit OZD track superstructure:

75% of all OZD rails are continuous welded rails. Continuous welded rail (or "velvet" rail) is a type of rail where the distance between the rail joints is much longer than the standard rail length (25 meters). Used mainly with concrete sleepers, this type of rail is particularly effective on high speed rail lines. It's designed as a sequence of 550-800 m rails with short jointed track sections (compensating areas).The rails can be welded into block-long rail bars reaching 30 km and more. It is planned to shift gradually to ballast less track that ensures higher track quality and better maintenance, especially on high speed lines.

PANDROL FASTCLIP: Pandrol-350 is an anchor rail fastener for high speed railways. It was designed in response to the growing need of faster and more efficient track construction, traffic speed increase (optimal passenger rolling stock speed 350 kph), and maintenance cost reduction. Pandrol-350 is delivered pre-assembled and cast into the sleeper (in the "parking" position). After sleepers and rails are laid, the clip can be simply pushed from the parked to the installed position (Fig.4).

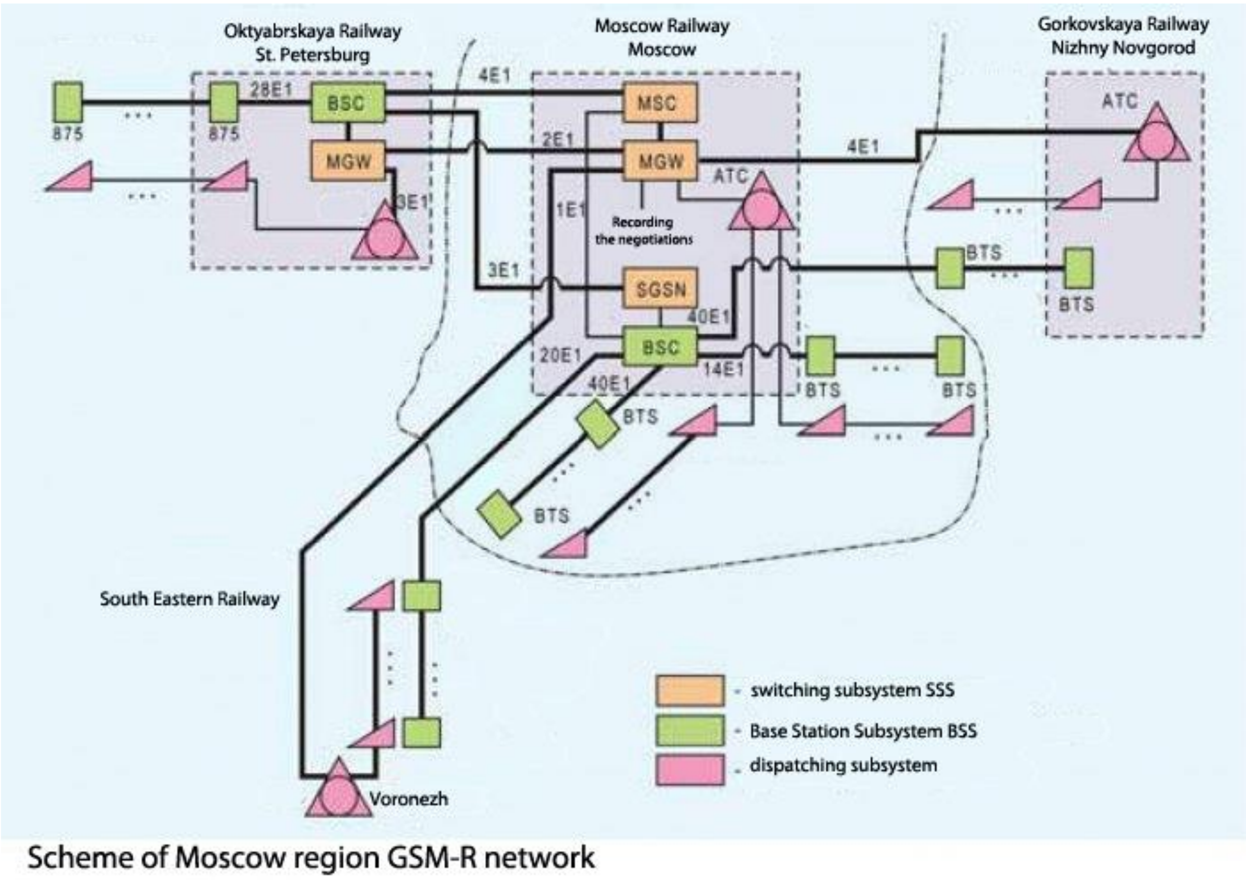

Fig. 3.*Scheme of Moscow region GSM-R network [2]*

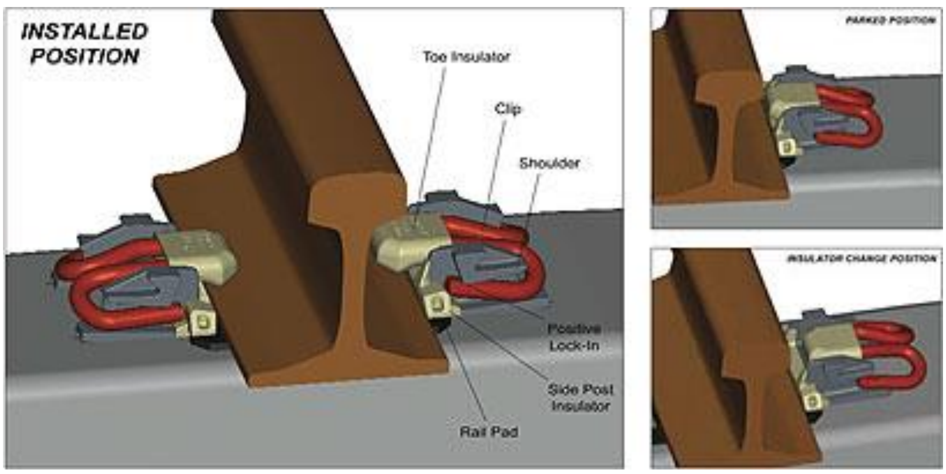

Fig. 4. *PANDROL FASTCLIP scheme [3]*

Point switch system retrofit on mixed traffic mainlines needs increased speed for the side track, points with bigger radius, more electric drives (at least 10), and drive control of point blades and wing rails. Such measures will allow to improve the dynamics when passing the switches and improve track superstructure geometry.

All these arrangements and solutions made it possible to increase the reliability and speed of freight on OZD. Since the beginning of 2016, OZD has transported 567 trains from point A to point B in strict compliance with the schedule with no delays on junction stations. A new train, "Freight Express" specializing in small company cargoes, is now running on OZD. 18 such trains have run since the beginning of the year.

For the first half of 2016, there were 67 security violations on OZD against 102 for the same period of 2015. OZD's traffic accident prevention measures have allowed a reduction in the number of accidents at level crossings by 73% for 8 months of 2016 against the same period in the previous year (from 26 recorded cases in January-August 2015 to 15 cases since the beginning of 2016). However, surely there are still issues to be resolved. For example, the traffic safety on OZD is very much under the influence of wagon repair companies that account for 94% of traffic accidents and events that occurred in the first quarter. Of 67 incidents 55 occurred through the fault of St. Petersburg office of VRK-1 JSC, 7 through the fault of Severo-Zapandy (Northwest) Branch of TMH-Service, 3 due to Oktyabrskaya Traction Directorate, and 1 due to Track Service and Track Machines Operation and Repair Department of Oktyabrskaya Infrastructure Directorate.

In general, the new solutions introduced on OZD showed a good performance. At the moment, the upgrade under the same scenario is planned for Moscow - Nizhny Novgorod section of Gorkovskaya Railway, and later for other RZD sections, including the Trans-Siberian Railway.

CONCLUSION

In conclusion, we can summarize that the matter of retrofit necessity for all the existing public tracks for the mixed high speed, passenger, and freight traffic is debatable in Russia. Understandably so, since the modernization of Oktyabrskaya Railway demanded considerable time and financial investment: the infrastructure retrofit alone is estimated at over 50 billion RUR. On the other hand, having in mind the vastness of Russia's territory and its railway network length, it would be at least utopian to think of covering all the country's regions with the network of dedicated high speed or freight lines. Therefore, the OZD case study will surely find use for the modernization of the mixed traffic on other mainlines.

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MODERNIZACJA OKTIABRSKIEJ MAGISTRALI KOLEJOWEJ (MOSKWA – ST.PETERSBURG - HELSINKI) JAKO PREZENTACJA POPRAWY INFRASTRUKTURY TRANSPORTOWEJ I LOGISTYCZNEJ NA KOLEJACH ROSYJSKICH

Streszczenie

W artykule omówiono zagadnienia związane z modernizacją Oktiabrskiej Magistrali Kolejowej (Moskwa - Petersburg - Helsinki), mających na celu poprawę infrastruktury transportowej i logistycznej rosyjskich kolei. Przeanalizowano wprowadzenie następujących technologii: system kontroli ruchu ALS 400, globalny system transmisji danych GSM-R Track oraz modernizację torów z ciągłymi spawami szyn, Pantrol-350 łączniki szynowe dla kolei dużych prędkości.

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