Main Research Directions in the Field of Railway Transport in Russia.
Main Results for the Last 2 Years

CHAIRMAN OF INTERNATIONAL RAILWAY RESEARCH BOARD (IRRB),
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BORIS LAPIIDUS

July 5-6, 2011, UIC HQ, Paris
## TASKS OF INNOVATIVE DEVELOPMENT OF RZD

1. Development and introduction of modern transport logistic systems, including high and medium speed transport

2. Development of intellectual control systems of transportation process on the basis of modern digital telecommunications and satellite technology, dedicated management information systems

3. Development of technologies for rolling stock production, that corresponds to the best world standards in terms of its principal characteristics (performance, speed, reliability) and its update on this basis

4. Introduction of innovative materials, technical means and technologies in the field of operation and maintenance of infrastructure and rolling stock to ensure reduction of life cycle cost and increase in reliability

5. Creating of effective resource management based on setting up a system of operational indicators of reliability and safety of infrastructure and rolling stock, methods of their use, taking into account risk assessment at all stages of their life cycle

ORGANIZATION OF RESEARCH WORK ON RUSSIAN RAILWAYS

Corporate Center of RZD Holding
Management Board

SCIENTIFIC AND ENGINEERING BOARD

Departments, director’s offices, subsidiaries

Space1520 Research Center (VNIIZhT)

Joint Scientific Council of JSC RZD

Russian Academy of Sciences
Academy of Transport
International Railway Research Board
International Scientific and Research Institutes

Research complex

JSC «IERT» (Economics and development)
JSC «VNIKTI» (Equipment)
JSC «NIIAS» (Informatization and Automation)
Centers, design bureaus, test grounds
Specialized and other academia (scientific support and training)
# Main Directions of Development of Equipment and Technologies on RZD

(As of 01.01.2011)

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<th>Description</th>
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</tr>
<tr>
<td>2</td>
<td>Use of satellite technology for monitoring of implementation of technological operations of repair and maintenance of infrastructure</td>
</tr>
<tr>
<td>3</td>
<td>Technology of interval traffic control based on integrated systems of coordinates</td>
</tr>
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<td>Technology of application of fiber optic digital communication systems</td>
</tr>
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<td>Mass introduction of LED technology, including traffic lights signalling</td>
</tr>
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<td>6</td>
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</tr>
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<td>Technology of use of liquefied natural gas as fuel for traction rolling stock</td>
</tr>
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<td>8</td>
<td>Systems of automatically controlled trains using energy optimum driving modes</td>
</tr>
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<td>9</td>
<td>Microprocessor systems of electric interlocking and automatic blocking</td>
</tr>
<tr>
<td>10</td>
<td>Complex of organizational and technical and technological measures to ensure energy effective transportation performance</td>
</tr>
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<td>11</td>
<td>Organisation of heavy freight traffic of trains of advanced weight and length</td>
</tr>
</tbody>
</table>
PHASED DEVELOPMENT OF TRAIN OPERATION CONTROL SYSTEM

2009 – 2010
- Highspeed Railway Transport
- Pilot Test Field of TCC Moscow - St.Petersburg
- Automatic Route Control (Test Run)
- Automatic Locomotive Control (Test Run)
- Freight Traffic
- TOCC of South-Ural Railroad "Auto-Dispatcher" - freight traffic
- Pilot Test Site on the Selected Direction

2011 – 2012
- Automatic Route Control
- Automatic Locomotive Control
- Object-oriented Model of the transportation process "Platform"
- Management of Train Operation by Fixed Train Paths
- Automated System for Charting
- Test Project
  Testing Groung Kropachevo-Issikul
  L=980 km, N=5 Train District Dispatcher
  The savings of operation costs = 250 million rubles per year

2013 – 2014
- System "Sochi-2014"
- Automatic Control of High-Speed Trains
- Auto-Correction of Traffic Schedule after Failures
- Regional Traffic Management Centers
  Management of train operation on railway test grounds
- Automatic Control of Trains on Schedule
- Rail lines operation on schedule
- Energy-saving technologies
INNOVATIVE TECHNOLOGIES IMPLEMENTED ON THE NORTHERN RAILWAY OF RZD

- **KASANT** – MONITORING AND ANALYSING OF TECHNIQUES FAILURES, ANALYSING THE CAUSES OF THEIR APPEARANCE (in operation from August 2009)

- **SIGNAL-L** – UPDATED INFORMATIVE AND PLANNING LOCOMOTIVE MAINTENANCE TECHNOLOGY SYSTEM (introduction into test maintenance from April 2011)

- **SIGNAL-BRING** – AUTOMATED SYSTEM OF ACTIVE CONTROL OF CONDITION, DISLOCATION AND DISTURBANCES IN THE WORK OF LOCOMOTIVE CREWS (introduction into test operation from April 2011)

- **KASAT (AS OKTD)** – MONITORING OF TRANSPORTATION PROCESS MAINTENANCE TECHNOLOGY (in operation from January 2011)

- **OSKAR-M (TEP)** – CONTROL AND ANALYSING OPERATIVE SYSTEM OF FIELD OPERATION – MODIFIED PANEL OF OPERATIONAL CHARACTERISTICS
PROJECT "TRANSSIB in 7 days"

PROJECT "TRANSSIB in 7 days" reducing transportation time of containers from eastern to western border of RUSSIA by 2 times

- Logistic center
  - Ust Luga

- To Berlin

- Warsaw
- Brest
- Krasnoe
- Moscow
- Saint-Petersburg
- Ekaterinburg
- Omsk
- Krasnoyarsk
- Chita
- Port Eastern
- Khabarovsk
- Zabaykalsk
- Nakhodka

Up to 14 days
9,0 days
8,2 days
7,6 days
7,0 days
6,6 days

Nakhodka-Krasnoe
9847 km.

- 910 km/d.
  - 9,0 days
  - (37,9 km/h)

- 1100 km/d.
  - (45,8 km/h)

- 1200 km/d.
  - (50,0 km/h)

- 1300 km/d.
  - (54,2 km/h)

- 1400 km/h.
  - (58,3 km/h)

- 1500 km/d.
  - (62,5 km/h)

- 2008
- 2009
- 2010
- 2011
- 2012
- 2015 and further

- decrease in the number and duration of stops
- increase the capacity and speed of the routing

- updating the legal framework guaranteeing optimization arms
- increasing the capacity and ability of the routing speed

- implementation of automation management system using an "electronic invoice"
- increase the capacity and speed of the routing

- increasing the capacity
- increase speed route (new stock)

- increasing the capacity
- increase speed route (new locomotive)

9847 km.
910 km/d.
1100 km/d.
1200 km/d.
1300 km/d.
1400 km/h.
1500 km/d.
8,2 days
7,6 days
7,0 days
6,6 days
7,0 days
9,0 days
Up to 14 days

(54,2 km/h)
(58,3 km/h)
(62,5 km/h)
(50,0 km/h)
(54,2 km/h)
(45,8 km/h)
(37,9 km/h)
AUTOMATED LUBRICATION COMPLEX
(rail-lubricator designed by CJSC «TVEMA FIRM»)

Main technical characteristics

<table>
<thead>
<tr>
<th>Car type</th>
<th>passenger, model 61-4179</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track gauge, mm</td>
<td>1520</td>
</tr>
<tr>
<td>Operating speed, km/h:</td>
<td></td>
</tr>
<tr>
<td>- minimum</td>
<td>5</td>
</tr>
<tr>
<td>- maximum</td>
<td>120</td>
</tr>
<tr>
<td>Capacity of tanks for lubrication, l</td>
<td>2000</td>
</tr>
<tr>
<td>Axle position of nozzle on running surface of rail, mm</td>
<td>11±2</td>
</tr>
<tr>
<td>Diameter of interchangeable nozzle for application of lubrication, not more than, mm</td>
<td>0,9</td>
</tr>
<tr>
<td>Specific consumption of lubricant to 1 km of lubricated rail in the curve, regardless the speed of the car, l</td>
<td>0,15-0,35</td>
</tr>
<tr>
<td>Turnaround shoulder with a single fuel lubricant, km</td>
<td>Up to 5000</td>
</tr>
<tr>
<td>Expectational annual economic benefit, million rbl.</td>
<td>0,65</td>
</tr>
</tbody>
</table>

In 2010, within the framework of Resource-Saving Programme two cars have been delivered to the Northern Railway. In 2011 – 2015, it is planned to put into operation 85 rail-lubricators.
is a two-car complex for integrated diagnosis of technical objects of railway infrastructure.

Manufacturer: CJSC NPC INFOTRANS

Diagnostic complex «ERA» provides:

**WITHIN THE SAME CHECKS:**
monitoring and automated evaluation in conjunction with the rail track and geodetic coordinate systems, more than 120 parameters:
condition of railway track;
condition of catenary system;
integrated video inspection of infrastructure;
condition of devices of railway automatics and telemecanics;
condition of radio communications.

- expanding the range of parameters and their diagnostic accuracy through the use of new development and integration of advanced systems;
- creation of a generalized unified database of passport data and the results of integrated diagnosis of infrastructure;
- minimization of maintenance stuff;
- use of data to calculate the reliability (reliability, availability, maintainability) and safety on the basis of the URRAN methodology in RZD infrastructure sectors.

<table>
<thead>
<tr>
<th>number of cars</th>
<th>units</th>
<th>Track test Cars</th>
<th>Diagnostic complex &quot;ERA&quot;</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of stuff</td>
<td>people</td>
<td>7</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Operating costs</td>
<td>thous.rbl/year</td>
<td>114 660</td>
<td>27 691</td>
<td>86 969</td>
</tr>
<tr>
<td>current maintenance</td>
<td></td>
<td>40 824</td>
<td>11 178</td>
<td>29 646</td>
</tr>
<tr>
<td>repair of equipment</td>
<td></td>
<td>42 664</td>
<td>12 060</td>
<td>30 604</td>
</tr>
<tr>
<td>using of locomotives</td>
<td></td>
<td>31 172</td>
<td>4 453</td>
<td>26 719</td>
</tr>
</tbody>
</table>

The effect of the implementation of a diagnostic complex "ERA" (thousands of rubles. Per year) excluding income of releasing train paths from handling of additional trains.
DIAGNOSTIC COMPLEX «INTEGRAL»

is a three-car system designed for integrated diagnosis of infrastructure objects.

Manufacturer: Tveema Group

MAIN FEATURES:

• automated control and integrated assessment of infrastructure at speeds up to 160 km / h;
  possibility of synchronous simultaneous control of full list of all infrastructure parameters;

• formation data to create a unified framework of generalized passport data of all infrastructure;

• minimization of maintenance stuff;

• creation of a common information structure of diagnostic data to generate the forecast changes in infrastructure planning and maintenance work on its actual condition;

• quality control of work performed on maintenance and repair of infrastructure;

• ensuring traffic safety.

The closest analogues of the diagnostic complex "INTEGRAL" are diagnostic systems "Archimedes" (Italy) and "Doctor Yellow" (China), with less functionality.

<table>
<thead>
<tr>
<th>Tested parameters</th>
<th>«INTEGRAL»</th>
<th>«ARCHIMED»</th>
<th>«YELLOW DOCTOR»</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent way</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Rail control</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Track geometry</td>
<td>32</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>GPR</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Construction clearance</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Catenary system</td>
<td>13</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Rail automation</td>
<td>19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Radio communication</td>
<td>12</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Information infrastructure of the train</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total:</td>
<td>118</td>
<td>49</td>
<td>49</td>
</tr>
</tbody>
</table>

IMPLEMENTATION to 2015 for one complex per year
APPLICATION OF POLYMER MATERIALS IN RAILWAY TRANSPORT
(LLC "Institute of Polymers")

Soundproof screen

Soundproof screen includes vertical supports, foundations, sound insulating panels. Sound Insulation panels made of galvanized steel. The cavity is filled with fibrous polyester panels. Side of the screen, facing the railroad tracks, has a perforation of 30%, D = 4 mm. On the other side a continuous sheet is used. Effectiveness of noise protection screen depends on the height, length, location and design of soundproof panels. The effectiveness of a screen tested (total length 200 m) at a distance of 7.5 m is 14-21 dBA at a distance of 25 m - 12-17 dBA at a distance of 50 m - 13 dB. The cost of construction on the mound screen length of 600 m on either side of railway track at a distance of 4.5 m from the axis of the extreme path estimated at 80 million rubles. Implemented: st. Sablin, May 2010

Insert in the rail web

Designed to reduce noise exposure. Made of special rubber composition with the addition of iron compounds. Sound Insulation capacity of 2,7-3,4 dB. Introduced: st. Sablin, May 2010

Cushion block under the sole of the boards of high-speed crossings

Mounted on high-speed turnouts at 82 bar. With using pads, shock absorbers under the sole of the boards level of the vibrodinamic impact transferred to ballast is reduced by 6-19 dB in the frequency band from 20 to 2,000 Hz and by 3-9 dB in the frequency range from 5 to 10 Hz. Implemented: st. Chudovo, May 2010

Rubber vibration damping panels

The panels are operated in the ground in the range of ambient temperatures from -60 ° C to +60 ° C, depending on their category. Effectively dampen vibration. At a distance of 7.3 m from the rail reduction in average levels of vibration acceleration is 2-3,9 dB (1.26 - 1.57 times). Implemented: st. Sablino, May 2010
LED LUMINOUS-SIGNALLING DEVICES

In the period 2004-2010 in the railway network implemented:

• LED head for crossings - 35,567 units.;
• Position indicators with LEDs - 33,100 units.;
• Routing indicators LED - 2,933 units. (according to the network devices demand shut down completely)
• Masted LED traffic lights heads - 886 units.

TOTAL LED equipment - 42,696 units.

The effect of the introduction of a unit. of LED equipment: 11 thousand rubles. per year

The overall effect of implementation of LED equipment: - 486 million rubles. per year

Investment project of implementation of LED-signal devices in 2011-2013

<table>
<thead>
<tr>
<th>Title</th>
<th>2011 г.</th>
<th>2012 г.</th>
<th>2013 г.</th>
<th>итого</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>Mln.rbl.</td>
<td>units</td>
<td>Mln.rbl.</td>
</tr>
<tr>
<td>Traffic lights-through passage of decentralized auto-lock (AB)</td>
<td>3,440</td>
<td>738</td>
<td>2,225</td>
<td>477</td>
</tr>
<tr>
<td>Traffic lights-through passage of centralized AB</td>
<td>–</td>
<td>–</td>
<td>395</td>
<td>85</td>
</tr>
<tr>
<td>LED heads for lights-through of decentralized AB</td>
<td>–</td>
<td>–</td>
<td>4,091</td>
<td>499</td>
</tr>
<tr>
<td>Obstruction lights</td>
<td>622</td>
<td>62</td>
<td>925</td>
<td>93</td>
</tr>
<tr>
<td>Station lights</td>
<td>–</td>
<td>–</td>
<td>1,407</td>
<td>346</td>
</tr>
<tr>
<td>Total</td>
<td>4,062</td>
<td>800</td>
<td>9,043</td>
<td>1,500</td>
</tr>
</tbody>
</table>
Co-developments of JSC "RZD" and railway industry with regard to creation of a new generation of locomotives

Eight-axle freight electric A.C. locomotive with asynchronous traction drive 2ES5 (LLC "PK" Novocherkassk Electric Locomotive Plant )

2ES5 - two-section mainline freight electric A.C. locomotive (25 kV, 50 Hz), eight-axle, with the asynchronous traction drive, hourly capacity on the ramparts of traction motors 8400 kW, microprocessor control system, design speed of 120 km / h, bearing-axle suspension of traction motors.

<table>
<thead>
<tr>
<th>Main features</th>
<th>2ЭC5K</th>
<th>2ЭC5</th>
<th>Changing, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous operation power, kW</td>
<td>6120</td>
<td>7600</td>
<td>24.2</td>
</tr>
<tr>
<td>Traction force of continuous operation, kN</td>
<td>423</td>
<td>536</td>
<td>26.7</td>
</tr>
</tbody>
</table>

Passenger electric locomotive with dual power supply with asynchronous traction drive EP20 (JSC "Novocherkassk Electric Locomotive Plant» - Alstom)

Start of development: 2008
Longer resource for 40 years and 12 million kilometers
Increasing the length of circulation area of the locomotive up to 2,000 km
Life-cycle cost of electric locomotive 1.5 bln. roub.
The integral effect in comparison with electric locomotive EP1 104.7 mln. roub.
Payback period 12.3 years

Freight electric D.C. locomotive with asynchronous traction drive 2ES10 (JSC "Ural Railway Engineering Plant» - Siemens)

Start of development: 2008
Life-cycle cost 521 million rubles.
The integral effect in comparison with electric locomotive 2ES6 44.9 mln.
Reduction of specific energy consumption by 8%.

<table>
<thead>
<tr>
<th>Type of locomotive</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>3П20</td>
<td>4</td>
<td>10</td>
<td>20</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>2ЭС10</td>
<td>10</td>
<td>20</td>
<td>25</td>
<td>50</td>
<td>55</td>
</tr>
</tbody>
</table>
Co-developments of JSC "RZD" and railway industry (locomotives)

Six-axle passenger electric DC locomotive EP2K (JSC "Kolomenskiy factory")
- Mass production: May 2008
- Comparison of the performance of passenger DC electric CS2 and EP2K

<table>
<thead>
<tr>
<th>Main features</th>
<th>ЧС2</th>
<th>ЭП2К</th>
<th>Changing, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power in hourly mode, kW</td>
<td>4200</td>
<td>4800</td>
<td>14,3</td>
</tr>
<tr>
<td>Life-cycle costs, mln.rbl.</td>
<td>830</td>
<td>750</td>
<td>-9,6</td>
</tr>
</tbody>
</table>

Freight eight-axle electric locomotive of DC 2ES6 (JSC "Ural Railway Engineering Plant")
- Mass production: July 2008
- Comparison of the characteristics of freight locomotives VL11 and of DC 2ES6

<table>
<thead>
<tr>
<th>Main features</th>
<th>ВЛ11</th>
<th>2ЭС6</th>
<th>Changing, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power in hourly mode, kW</td>
<td>5360</td>
<td>6480</td>
<td>20,9</td>
</tr>
<tr>
<td>Life-cycle costs, mln.rbl.</td>
<td>650</td>
<td>510</td>
<td>-21,5</td>
</tr>
</tbody>
</table>

Freight locomotive twelve-axle 2TE25A (JSC "Bryansk Engineering Plant")
- Start operation: March 2009
- Comparison of the characteristics of freight locomotives and 2TE116 and 2TE25A

<table>
<thead>
<tr>
<th>Main features</th>
<th>2ТЭ116</th>
<th>2ТЭ25А</th>
<th>Changing, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity in continuous duty, kW</td>
<td>2x2250</td>
<td>2x2650</td>
<td>6,0</td>
</tr>
<tr>
<td>Traction force in continuous duty, kN</td>
<td>510</td>
<td>780</td>
<td>52,9</td>
</tr>
<tr>
<td>Specific fuel consumption g / kWh</td>
<td>206</td>
<td>198</td>
<td>-4,5</td>
</tr>
<tr>
<td>Life-cycle costs, mln.</td>
<td>2280</td>
<td>1770</td>
<td>-22,4</td>
</tr>
</tbody>
</table>

Delivery in 2011-2015

<table>
<thead>
<tr>
<th>Type of locomotive</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>ЭП2К</td>
<td>35</td>
<td>35</td>
<td>50</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>2ЭС6</td>
<td>90</td>
<td>91</td>
<td>86</td>
<td>70</td>
<td>65</td>
</tr>
<tr>
<td>2ТЭ25A</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>30</td>
<td>56</td>
</tr>
</tbody>
</table>
INTEGRATED SYSTEM OF ROLLING STOCK DIAGNOSTICS

Automated control system of geometric parameters of wheel pairs of freight cars using a laser scanning

Automated control system of heating axle-box of rolling stock

Installed 4969 KTSM sets, including:
KTSM-01 - 190
KTSM-01D - 2564
KTSM-02 - 2215

Number of stops trains at intermediate stations for 2010 decreased by 24.4%, while increasing the number of trains are controlled by 4.6%.
Number of stops was reduced by 6.5 thousand

The economic effect - 270 mln. per year
Sections where KTSM-02 devices which are fully equipped with –
Moscow - St. Petersburg - Nakhodka, Moscow - Arkhangelsk -
Malenga, Moscow - Suzemka, Moscow - Krasnoe, Artyshta - Vhodnaya

Been established 59 systems in the basic PTO of Russian railways.
For 2010 on this criterion was uncoupled 27 966 freight cars.
In 2011 is planned implementation of four complexes of LPS to Moscow, North Caucasus and East-Siberian Railway

Delivery in 2011-2015

<table>
<thead>
<tr>
<th>System</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>КТИ</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>КТСМ</td>
<td>548</td>
<td>537</td>
<td>365</td>
<td>543</td>
<td>542</td>
</tr>
</tbody>
</table>
Currently 5 systems are in operation on October, North and South Urals, West Siberia and the Far Eastern Railway
Concept of Situation center was elaborated and approved in 2010. Arrangement project was developed. Integrated complex development of automation system for Situation center will be completed in 2010-2011.
DEVELOPMENT OF HIGH-SPEED TRAFFIC IN RUSSIA

Already realized

- **«ALLEGRO»**
  - From Russia, St. Petersburg to Finland, Helsinki
  - Distance: 415 km
  - Time: 3 h. 30 min.

- **«SAPSAN»**
  - From St. Petersburg to Moscow
  - Distance: 650 km
  - Time: 3 ч. 45 мин.

- **«TALGO»**
  - From Russia, Moscow to Poland, Warsaw
  - Distance: 488 km
  - Time: 18 h.

At the stage of realization

- **«DESIRO»**
  - From Russia, Moscow to Germany, Berlin
  - Distance: 947 km
  - Time: 6 ч. 30 мин.

- **HEADWAY:**
  - 10 min.

More routes and destinations are mentioned in the diagram, including flights to Sochi, Adler, Imperetinskiy resort, and Olimpiyskiy park.
### Implementation results (for 2007-2010) of Strategy of Railway Transport Development in the Russian Federation by 2030

#### December 17, 2009

**HIGH SPEED TRAFFIC WAS OPENED IN THE AREA St.-PETERSGURG – MOSCOW BY ELECTRIC TRAINS «SAPSAN»**

- 8 sets of trains per day, travel time – 3 h 45 min., max speed – 250 km/h, seats sold – 2 272 614 (from exploitation start till 31.03.2011), average use of train capacity – 85.0%

#### July 30, 2010

**HIGH SPEED TRAFFIC WAS OPENED IN THE AREA MOSCOW – NIZHNIY NOVGOROD BY ELECTRIC TRAINS «SAPSAN»**

- 2 sets of trains per day, travel time – 3 h 55 min., max speed – 160 km/h, seats sold – 315 231 (from exploitation start), average use of train capacity – 66.7%

Revenue from passenger traffic by “Sapsan” trains is 7.7 billion rubles (from exploitation start till 31.03.2011).

#### December 12, 2010

**HIGH SPEED TRAFFIC WAS OPENED IN THE AREA St.-PETERSGURG – HELSINKI BY ELECTRIC TRAINS «ALLEGRO»**

- 2 sets of trains per day, travel time – 3 h 36 min., max speed – 220 km/h, seats sold – 70 726 (from exploitation start till 31.03.2011), average use of train capacity – 47.6%
Introduction of “Autodriver” System for Passenger Locomotives

“Autodriver” for diesel locomotives TE70 and TE70BC

The system provides for automatic traction and braking control to achieve energy saving train movement:
- fuel saving up to 8%, and oil-up to 3%
- enabling one-person driving mode
- increase in safety

Annual effect is 10,000 USD per locomotive
360 locomotives are required to be equipped with “Autodriver”

“Autodriver” for the electric locomotive ЭП2К
- fuel saving from 2 to 7%
- enabling one-person driving mode
- increase in safety
- Increase in labor productivity/

Annual effect is about 4,000 USD per locomotive
77 locomotives are required to be equipped
Emerging Solutions to Increase Efficiency of Locomotives

Two-diesel shunting locomotive ChME-3

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual savings, USD</td>
<td>540</td>
</tr>
<tr>
<td>Fuel saving, %</td>
<td>10</td>
</tr>
<tr>
<td>Maximum speed. kmh</td>
<td>95</td>
</tr>
<tr>
<td>Starting traction effort (adhesion 0.25), kN</td>
<td>302</td>
</tr>
<tr>
<td>Diesel power, kW</td>
<td>2x478</td>
</tr>
</tbody>
</table>

Two-axle low power locomotive

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal speed.kMh</td>
<td>80</td>
</tr>
<tr>
<td>Traction effort, kN</td>
<td>91,3</td>
</tr>
<tr>
<td>Power, kW</td>
<td>441</td>
</tr>
<tr>
<td>LLC expenses decrease (to ChM-3)</td>
<td>260,000USD</td>
</tr>
<tr>
<td>Annual savings</td>
<td>30,500USD.</td>
</tr>
</tbody>
</table>

Supply ,psc

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>5</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
</tr>
<tr>
<td>2013</td>
<td>20</td>
</tr>
<tr>
<td>2014</td>
<td>20</td>
</tr>
<tr>
<td>2015</td>
<td>20</td>
</tr>
</tbody>
</table>

Development of JSC “VNIKTI”

Shunting diesel-gas locomotive ChME3G using natural compressed gas

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of diesel fuel substitution</td>
<td>60</td>
</tr>
<tr>
<td>Emission decrease, %</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Operational savings per locomotive,</td>
<td>&gt; 11700 USD</td>
</tr>
</tbody>
</table>
ALTERNATIVE FUELS AND POWER EQUIPMENT USAGE

- **Alternative fuels**
  - **Natural gas:**
    - Gas-turbine locomotives ТЭМ18Г, ЧМЭЗ. Diesel fuel replacement up to 50...60% by gas
  - **Bio fuel:**
    - Reduction in environmental pollution

- **Alternative power equipment**
  - **Gas turbine engine:**
    - 100% diesel fuel replacement by gas;
    - Costs reduction on maintenance and repair
    - Increase in time between repairs
  - **Electrochemical generator:**
    - Ecological cleanliness;
    - Minimal maintenance and repair.

**Outcome:**
- ✔ Coats reduction on fuel purchasing;
- ✔ Costs reduction on maintenance and repair;
- ✔ Reduction in energy consumption;
- ✔ Costs reduction on repair;
- ✔ Increase in locomotive effectiveness.
ENERGY STORAGE APPLIANCE

**Locomotives**

**Electric motive power**
1. Providing the traffic of neutral inserts and air gaps in traction condition
2. Possibility to entry non-electrified sections

**Self-contained locomotives and motor driven rolling stocks (MDRS)**
1. Reduction the installed capacity of diesel when specific haulage capacity is constant
2. Reduction of energy consumption
3. Improvement of environmental characteristics
4. Run of locomotive diesels of operated series

**Power supply**
1. Compensation of peak loads by passing of trains.
2. Station capacity reduction
3. Emergency power of substations

**Advanced types of stores:**
1. Capacitors.
2. High molecular stores.
3. Lithium-ion, lithium-pol batteries.
4. Stories on basis of carbon technologies.

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**Economy of diesel fuel consumption to 40%**

**Reduction of energy consumption to 10…15%**

**Economy of diesel fuel to 40…50%**

**Economy of electric power 10…15%**

**Power reduction of railway substation**

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**VNIIZHT WORKS:**
- Construction of hybrid switch locomotives and motor driven rolling stocks (MDRS);
- Technical decisions on the application of stores in electric power supply economy and at electronic payment system (EPS)
SYSTEM OF SIMULATION MODELLING “ELBRUS”

The basis of the system structure is Elbrus simulation model train with lock-on to them locomotives and crews.

Elbrus system can work in long-term, operational planning and be used to conduct a situation analysis and control.

Calculating the number of technology driven locomotives taking into account conditions of train traffic passage.

Calculation of parameters of using locomotives and locomotive crews.

Assessment of technical and economic efficiency of long-term changes in the organization of train operation.

Assessment of capacity utilization and carrying capacity of the railway network.

Reducing the number of freight trains by using technology of heavy traffic.
The First Main Line Liquid Gas-Turbine Locomotive

Trial operation on Moscow Railway

Emission decreased by 5 times and became lower than EC2012 requirements

There is a proposal from Caterpillar for joint development of gas-piston and gas-diesel locomotive

<table>
<thead>
<tr>
<th>Locomotive type</th>
<th>2ТЭ116</th>
<th>ГТ1</th>
<th>Change, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Cycle Cost</td>
<td>1,17</td>
<td>0,98</td>
<td>-19,4</td>
</tr>
</tbody>
</table>

Turbine power – 8300 kW
Turbine type – NK 361
Turbine Life > 100,000 h
Liquid gas volume – 17 т
Distance – 1000 km

Expenses GT1 on 1 tonne of cargo transportation ГТ1 are by 30% less than diesel locomotive 2ТЭ116
Introduction of Light-Emitting Diodes in JSC “Russian Railways”

Power consumption before introduction: 5,443 kW

Power consumption after introduction: 1,456 kWh

Energy saving: 13.7 mln kW/h

Electric energy saving, USD: 1.160 mln

Operational expenses savings, USD: 1.42 mln

2008-2010 Investments, USD – 25.4 mln

2011 – investment plan, USD -33,000,000

- 3,800 indicators and signs
- 35,000 traffic lights
- LED illumination of 22 station and 14 depots

Perovo station: illumination power decreased from 740 to 237 kW
Alternative Sources of Energy

The Russian first hydrogen power installation for railway communication

Reserve energy source at Malino station, Moscow Railway

Advantages:
- Autonomy, high efficiency, soundless, ecological safety, small dimensions
- Fuel supply- 300 m³ of hydrogen under high pressure

Solar panel for water heating

USKB-1 set. Astrakhan-2 railway station

USKB-1 had been introduced at 5 railway:

Energy saving (2008-2010:)
- Coal 97.3 tonnes
- electric energy 1,123,000 kW/h
Significant Measures for Environment Protection

Automated system of Environment protection control (EPC “Ecology”)

From 2012 it is planned to manage environment control in all Russian Railways with the help of EPC “Ecology”.

Laboratory module for monitoring water, air, soil, noise, vibration, electromagnetic radiation, toxic state of water and wastes - at the Chelyabinsk station of the Zabaykal Railway.
Space Technologies Used in JSC “RZD”

- Restoration trains - 17 psc.
- Space communication and passenger train monitoring
- Glonas
- GPS
- Locomotives and multiple electric units
  - Locomotives: 5663 units
  - Multiple units: 1660 units
- Mobile diagnostics and monitoring, 39 units
- Hazardous cargo
- Track machines
  - 8 units
  - 534 units
  - 197 units
- Fire trains - 129 units
- Mobile lubrication vehicle
  - 57 units
- Mobile lubrication vehicle
  - 4 units

Restoration trains: 17 units
Space communication and passenger train monitoring: 8 units
Fire trains: 129 units
Locomotives and multiple electric units: 5663 units
Multiple units: 1660 units
Mobile diagnostics and monitoring: 39 units
Hazardous cargo: 8 units
Track machines: 534 units
Locomotives: 142 units
Fire trains: 57 units
Mobile lubrication vehicle: 4 units

Total units: 5663 + 1660 + 39 + 142 + 4 = 7518 units

- Decrease in track repair intervals by 25%.
- Total effect: Coordinate methods of lubrication equipment control (2012-2013).
  - Electric energy savings by 3%, wheel wear decrease by 2%, rail wear in curves by 5%.

Total effect:
  - Capacity increase by 2-2.5 times (if track is ready).
- Coordinate methods of design (2012-2014).
  - Productivity increase by 15-20%.
  - Decrease in track repair intervals by 25%.
  - Decrease in maintenance expenses by 10% when condition-based track maintenance is used.
- Coordinate methods of control fire- and wrecking trains (2012-2013).
  - Operational expenses decrease.
Thank you for your attention!