EFFICIENCY OF TRANSPORT PROCESSES IN THE FAR NORTH

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ABSTRACT

The article is devoted to the analysis of modern approaches to ensuring the efficiency of transport processes in the regions of the Far North and similar regions. Taking into account the natural and geographical specifics in those zones, the risks of deviating the planned route trajectories of traffic are particularly high, as well as the probability of occurrence of abnormal situations that creates difficulties in introduction of mathematical methods of transport planning, complex automated control systems using the means and technologies of transport telematics, satellite navigation, mobile and radio communication. The main goals of creation of an automated satellite navigation system for support of road transport are presented, the functions of information collection and transmission using telematics means are provided, which are used to equip the vehicles of enterprises. The model provides that the received coordinates are automatically stored in the receiver's non-volatile memory and transferred to the local operator centers of the regional branches.

Keywords: satellite navigation, efficiency, dispatching control, Far North, road transport, cargo transportation, GLONASS/GPS.

Background. *Modern approaches to solving problems of functioning and development of the transport complex, improving the technology of cargo transportation, the structure of material and technical support of the regions of the Far North and similar localities should be built on the basis of advanced methods of managing automobile transport using the newest information systems and equipment created for the northern territories [4].*

It is worth recalling that the regions of the Far North of the Russian Federation and territories similar to them by their natural and climate conditions occupy about 70% of the territory of Russia (Pic. 1), and 8% of the country's population live there. This economic-geographical zone includes all or part of 25 constituent entities of the Russian Federation. The importance of the North for the economy is determined primarily by the raw material potential [5].

It is clear that the presence of harsh natural conditions, permafrost, seasonal specifics of highways and waterways, of a compound infrastructure dictates the need to seek solutions in the field of intelligent transport systems, the use of telematics, satellite navigation, forms of monitoring and dispatch control [1–3].

Objective. *The objective of the authors is to consider different aspects of provision of efficiency of transport processes in the Far North of Russia.*

Methods. *The authors use general scientific methods, comparative analysis, evaluation approach.*

Results.

Correlation of problems and forces

The development of transport and its infrastructure is a priority task of the federal policy of the Russian Federation and of the regional authorities. Basing on the transport strategy of the Russian Federation until 2030, there are three main problems of the transport system in the North:

- *lack of territorial integrity;*
- *technical and technological backlog of transport infrastructure from the world level;*
- *lack of coordination in the work of various modes of transport.*

Along with the requirements for transport services, there are, however, specific problems associated with complex natural and climatic conditions, uneven development of infrastructure for different modes of transport [14].

In the transport services provided to enterprises, organizations, companies in the North of the Russian Federation at the ambient temperature ranging from +40° to -60°C, the role of road transport is particularly significant. This is due to the nature of the requirements:

- *for high reliability and safety of transportation process;*
- *for possibility of sustainable operation in extreme conditions and emergency situations.*

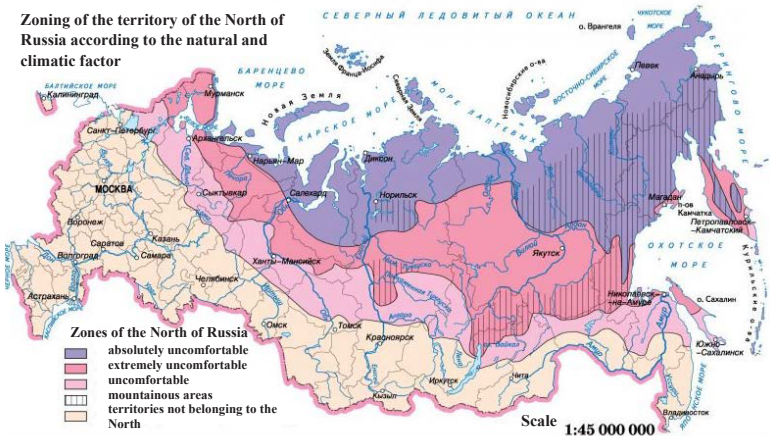
In this regard, one cannot but realize that the tasks assigned are in the field of accessibility of road transport, and the use of other modes of transport in these positions is, as a rule, unjustified. The growth in the volume of freight transportation by rail and air transport, complexity of construction of transport infrastructure due to the geographical remoteness of the northern regions of the Russian Federation attracts attention to the issues of improving management technologies, coordinating efforts in organization of transportation process, but the prevailing ratio of competing and interacting forces is unlikely to be changed in the near future.

At the same time, the increasing risks of deviating the planned route trajectories of traffic, laboriousness of finding optimal options due to occurrence of contingencies create additional considerable difficulties in introduction of mathematical methods for planning transportation, raise increased requirements for their regulation and tactical flexibility in making managerial decisions. Judging by a number of factors, optimal decisions are only possible with the competent and technically provided use of automated control systems of the transport process [5, 15].

Development of an automated navigation system

Automated navigation system for monitoring, dispatching control and accounting of road transport in the North of the Russian Federation is a distributed system in its structure, provides monitoring and dispatch control of dedicated facilities and transport [6–8]. The system is based on the principles of unification of its main functional modules and standardized approaches to implementation of basic functions of dispatching control – both transport processes and elements of transport and information service of technological processes. As they are unified for different modes of transport, the systems differ from each other depending on the characteristics of transport technology, but this does not reduce the importance of their basic (standardized) technological components at different levels of information processing in automated systems [9–13].

The technology of development of the transportation process depends on the parameters and characteristics of the transported objects, the traffic schedule, and also on



Pic. 1. The territory of the North of Russia.

developed route. The use of modern information technologies contributes to development of the structure of the relations of the participants in the transportation process, accumulation of information on transportation, increase in the parameters of development of equipment involved in the transport (production) program [16–20].

The development of information technologies in road transport, based on the use of controllers, computer equipment, microelectronics, satellite navigation, geoinformatics, implements the possibility of creating systems for operational control and management of road transport within the transportation process. The use of information technology and telematic tools implies the use of a complex of hardware and software, including those belonging to satellite navigation. Together, they allow to significantly improve planning, control, regulation, and the quality of service during transportation [2].

Improvement of systems and methods of dispatcher tracking of rolling stock and vehicle fleet operation is one of the most important reserves for increasing the efficiency of transport vehicles' [21–23].

The developed set of procedures within the distributed monitoring system is considered as an organizational, technological and technical activity whose purpose is to introduce methods of objective instrumental control of the transportation process using means and technologies of transport telematics, satellite navigation, mobile and radio communication [3, 17].

The main objectives of creating an automated satellite navigation system for supporting road transport in the northern regions of the Russian Federation are:

• improving the quality of performance of the planned traffic of transport vehicles (TV), improving transport services for construction sites and infrastructure (monitoring indicators such as safety, accuracy, etc.);

• ensuring the efficiency of use of various types of transport vehicles (TV), increasing labor productivity and production culture, reducing direct costs in production;

• improving safety of the transportation process through information support for emergency response;

• prompt information of representatives of the operating enterprise, local control bodies, as well as bodies and structures controlling the transportation process;

• increasing the efficiency of the dispatching services by automating manual procedures and using modern telecommunication technologies;

• improving safety of drivers, transported goods and TV themselves;

• complex information and diagnosis on the status of all monitored parameters read from TV board;

• operational interaction with road repair companies and emergency data transfer when traffic obstacles are detected on the roadway;

• call for technical assistance to vehicles as soon as possible in case of a malfunction on board of a TV.

Dispatch control functions

The technology of dispatching support and control of the transportation process is realized in full, while automation [9–11] is required for:

• current planning, ensuring that the features of the transportation process are taken into account;

• information support and instrumental recording of transport work, regardless of the type of vehicles and the object of transportation;

• analysis and control of movement due to tools for locating transport units, communication equipment and software and hardware visualization on maps of regions displayed on the monitor screen;

• operational communication with drivers – voice and text messaging;

• simplified call for technical assistance at the expense of communication facilities installed in a location accessible to a driver;

• operational analysis based on computing and software, which displays information on the level of performance of the transport operation (including control of the elements of the traffic schedule) and facilitates the operational control of traffic;

• technical means of visualization accessible to consumers, as well as other mechanisms for obtaining information on actual traffic;

• transfer of the characteristics read by the telematics equipment installed on board of a vehicle in order to ensure the maximum level of tracking of the parameters of the transported objects.

To illustrate the display of the information exchange function Pic. 2 shows a scheme of information exchange.

Automated navigation system for accounting and control of road transport ensures implementation of related tasks and functions, the main of which [13] are summarized in this chapter.

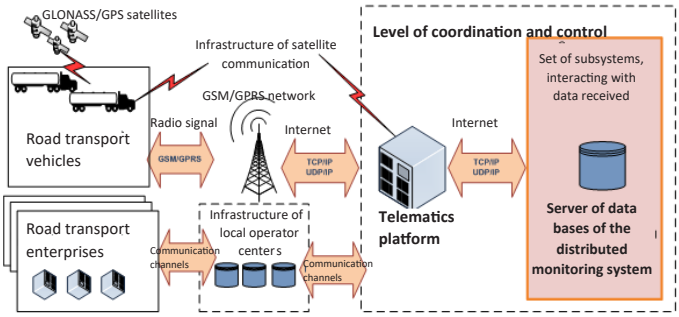
a) Automated monitoring and control of the transportation process with minimal staff involvement, including:

– control of planned and unscheduled traffic of vehicles on the road transport network, automatic reporting of deviations from the plan;

– managerial interventions of system dispatchers who control and manage the movement of road transport in an interactive mode with a computer system;

– processing and output of operational information on work of individual TV, units, trucking enterprises in general.

b) Dispatch control and regulation of the cargo transportation process.



Pic. 2. The scheme of information exchange of the navigation system of accounting and control of the operation of transport vehicles.

c) Providing information exchange of data with the TV of enterprises both in the process of performing the task, and in case of emergency situations.

The function of collecting and transmitting information is carried out by means of telematics, with which the TV of enterprises are equipped. While traveling along the routes, the on-board navigation and communication equipment performs the process of transmitting data on the geographic location of the vehicle. Operational reports are formed on the basis of information exchange by means of the global navigation satellite system (GLONASS/GPS) and on-board navigation and communication equipment [7, 19]. The obtained TV coordinates are automatically stored in the receiver's non-volatile memory and transmitted to the local operator centers of the regional branches by using various communication channels (satellite communication, GSM, VHF radio communication, etc.).

In the process of forming an array of information received by local operator centers, primary processing is performed in accordance with established systemic procedures. Information exchange is supported by modern means of communication, which ensure a high data transfer rate. At the same time, the telematics server is the main element of the telematic platform in the process of collecting and transmitting information. Universal architecture in combination with simple algorithms and high throughput of the telematics server allow connecting to the system up to several thousand subscriber terminals without a noticeable decrease in system performance in general. To increase reliability of the system, data streams can be duplicated to another similar server that performs backup functions [18, 20].

d) Formation and issuance of reporting and analytical forms.

e) Creation of archives of long-term storage of data with daily archiving of navigational information, orders, protocols of actions of dispatchers and drivers (control actions, reports, negotiations, etc.).

f) Calculation of indicators and formation of current and cumulative databases for implementation of planned tasks and accounting for the performed transport work.

g) Formation of shift-daily assignments for transportation.

h) Determination of TV location.

On the electronic map in real time dispatching services should determine location of their vehicles with a certain accuracy and discreteness of data transmission, sufficient for effective monitoring of traffic [6, 7].

i) Operational planning of transport work of motor vehicles.

j) Accounting and control of TV traffic.

The implementation of these functions is carried out in the system on the basis of regular retrieval of location of the monitored vehicles through the signals of global satellite navigation GLONASS or GLONASS / GPS.

k) Fixing, preliminary processing and storage of navigation data coming from controlled vehicles:

- *number of the object of the radio station, from which the navigation mark was received;*
- *geographical latitude and longitude of the object;*
- *world time in which navigation data were defined;*
- *speed of the object;*
- *azimuth of motion (position relative to the cardinal points);*
- *sign of reliability of a mark.*

Each navigation mark is stored in the internal buffer before being transferred to the system database. In addition, the server maintains a log of received marks for each radio station and, in case of omissions (unread marks), requests them again.

l) Archiving of the main events in the system based on satellite navigation data processing.

Conclusion. *Taking for the ground the analysis of modern approaches to ensuring the efficiency of transport processes in the Far North and areas similar to them, it can be concluded that the software and hardware of a typical automated navigation dispatch system for vehicles can lead to a reduction in the use of «manual operations» by dispatch personnel and maximum automation of operational cargo transportation management. In this case, there is a need to justify further steps for improving the functions and operations of the dispatching personnel, which are directly related to development of mathematical models and methods for processing navigational data.*

Methods of monitoring the transportation process, determining the location of motor vehicles in space and time, which will increase the efficiency of transport work, save government and human resources are proposed. In particular, the possibilities of using telecommunications in the North are considered, which are quite feasible for implementing on the basis of coordinate-time and navigation support with the help of global navigation satellite systems, geographic information systems, means and technologies of transport telematics.

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