РАДИОФИЗИКА ЖӘНЕ ЭЛЕКТРОНИКА
РАДИОФИЗИКА И ЭЛЕКТРОНИКА
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Use of GPS communication on the railroad

Introduction of the modern satellite technologies in optimization of management of infrastructure and traffic safety on the Karaganda railroad is a basis of transition to complex management information technologies of the highway work with use of means of satellite navigation, monitoring and communication. The main objective of creation of road geo-informational system is introduction of new technologies in the sphere of safety and train dispatching, management of transportation process and logistic operations, monitoring of infrastructure condition, engineering geodetic support of works on projection, construction and operation of the railroads. This article describes the GLONASS / GPS monitoring system. The main advantages of implementing this system in the work of railway transport are indicated. The principles of operation of the monitored monitoring system are presented in the form of illustrations and structural diagrams. The use of GLONASS / GPS monitoring system using ground-based correcting GPS stations will ensure fast and high-quality engineering and geodesic performance in the design, construction, repair and maintenance of Karaganda railway facilities.

Keywords: traffic control center, wireless system, mobile solution, GPS monitoring, GIS map.

The necessity of application of satellite technologies on railway transport does not raise doubts any more. It is provided by further prospects of branch development, including plans of transition to the high-speed and speed motion, and also increases in intensity of the transport traffic streams on highways.

In these conditions the advance to higher qualitative level of transportation management and traffic safety of trains becomes the key to success. And, in turn, it demands basic changes in the sphere of coordination and time ensuring work of railway transport. It is necessary to have the most exact information on dislocation of a rolling stock, at any time and under any weather conditions, to be able to control its movement and a condition of onboard systems. But it is impossible to solve this problem without modern global navigation satellite systems, such as GLONASS/GPS, and high-effective digital communication.

Soon the work on equipment of navigation of passenger electric locomotives by satellite systems will come to the end. All this will allow to provide the remote reflection of provision of the train on the electronic scheme of sites of the Karaganda railroad in real time. Use of such navigation systems will give the chance to control operational and financial performance, and also precisely and quickly process production information [1].

Modern GPS monitoring of transport on the railroad will allow:

– To make satellite GPS control of railway transport while its movement in the real time and to obtain all specifications: time for start of the engine, speed of movement of the train, acceleration, braking, place and time of stops.

– To use GPS control of fuel consumption for transport on the railroad (using the exact sensor of fuel consumption), for the purpose of suppression of casual leaks, discharge of fuel and inappropriate use of vehicles.

– To increase efficiency of railway transport use, to conduct the general system of the accounting of fuel consumption, to modify employment of drivers, to plan the operating mode, to cut down expenses on servicing and to repair railway transport.

– To make general reports on the basis of GPS of railway transport monitoring, to optimize schedules, to simplify work of dispatching services.

– The satellite GLONASS monitoring system will also allow to control safety of freight and its movement on the railroad, preventing its losses by drivers.

Also the important fact that on the basis of this system it is possible to develop system of the warning the driver of the situation on a railway crossing which the train is approaching to. And efficiency of access to information on the provision of the train on the scheme of sites of the railroad will conduct traffic safety of trains to new level [2].

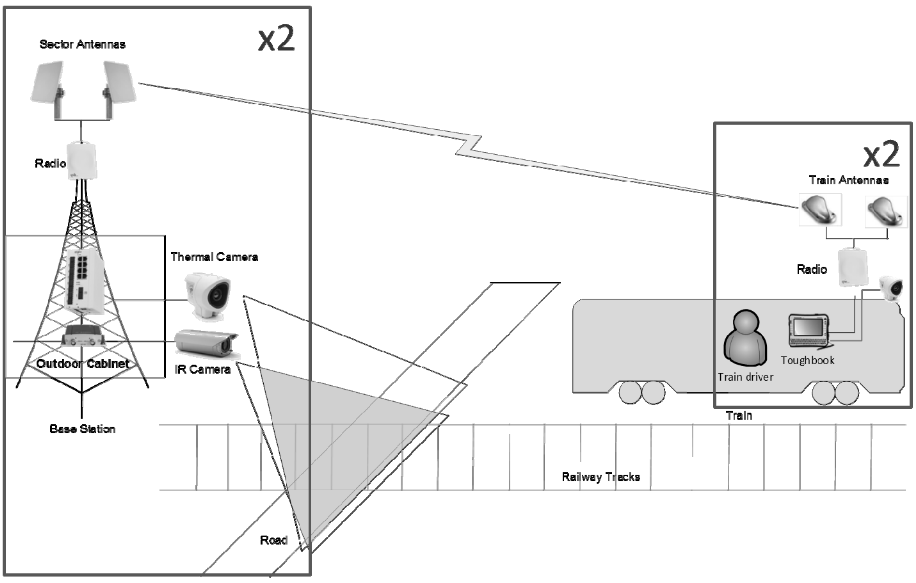
Railway crossing. The cells located on railway crossings are sent to both parts of train traffic for the purpose of the best review. Each cell is connected to the control unit which include the block of program control by formation of video stream and the block of video of analytics. Control units are connected through a special communicator to the wireless device of data transmission. The BST system covers space in both directions, using two antennas directed in both directions of the traffic. Antennas are installed near the crossing.

Locomotive. The train-driver will see the video stream from moving in real time when the train is at the distance about 5–7 km from a railway crossing (depending on conditions of direct visibility and precise arrangement of moving). The video stream will be visualized on the LCD screen of the monitor located in the driver cabin. The monitor through the Ethernet cable will be connected to the radio receiver located on the locomotive. For reception of information on the locomotive two antennas will be provided. The locomotive has to be equipped with GPS to transmit the location to CCSP and further to CC by driving on a site.

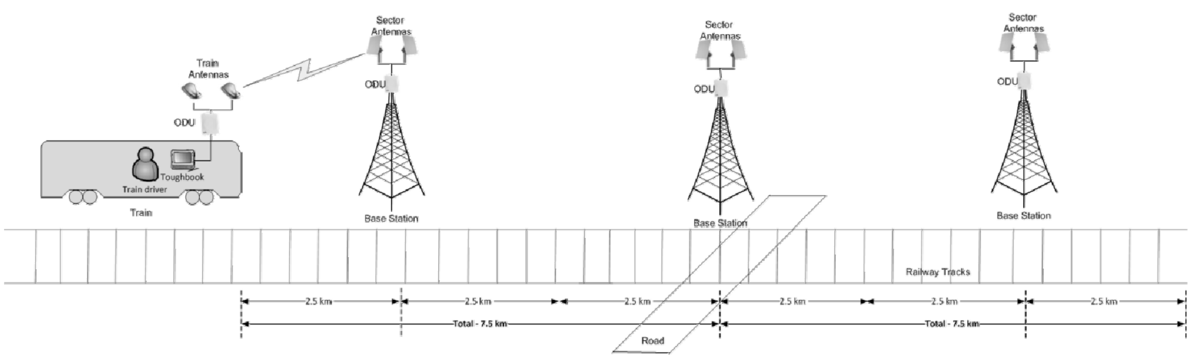
Control center of driving. The operator of control center driving will be able to see data-flow video in real time from the crossing in the system of video management when the train is at the distance of 5–7 km from the crossing (on condition of direct visibility and precise information about the arrangement of crossing), on optical network / wireless lines of dumping (depends on the existing infrastructure) [3].

When the train is in the zone of wireless communication, on the CCD panel its GPS coordinates are displayed.

The topology of system is shown on the following Figures 1a and 1b.



a)



b)

Figure 1. Topology of wireless system

The wireless system is realized by the principle of radio PtMP (Point to Multi Point). Each BS can support two locomotives at the same time, providing speed. The structure of wireless system in the locomotive is shown in Figure 2.

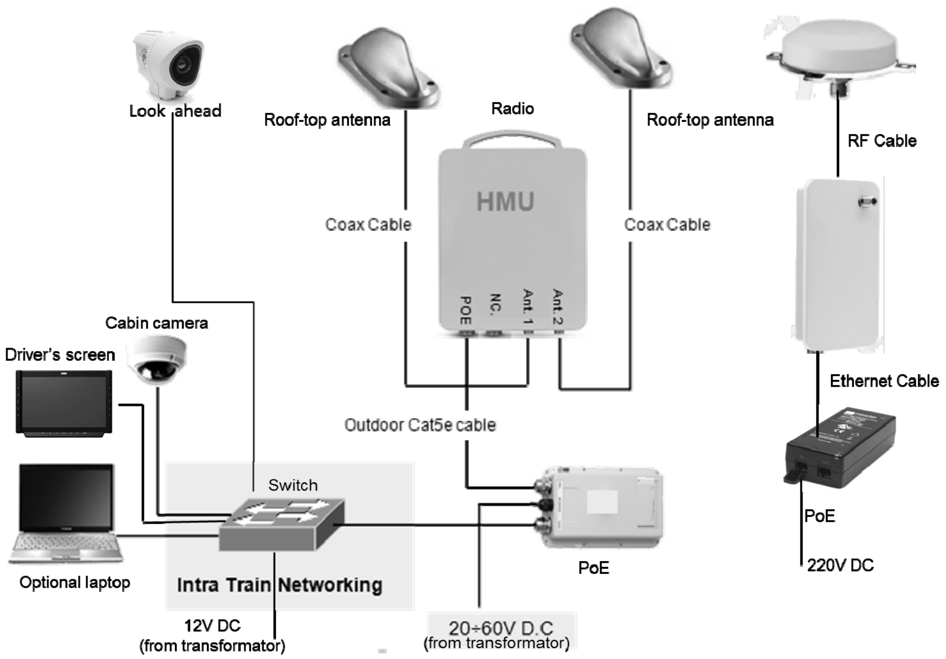


Figure 2. Structure of Wireless System in the locomotive

Mobile solution. The unique solution which provides a reliable high-performance wireless communication with train structure, moving with speed up to 200 km/hour. The solution is based on covering of a site of a way by means of BS each 5–7 kilometers, when ensuring fast relay transfer service between base stations. The offered wireless technologies provide high reliability and a good channel capacity by transfer of a video stream. Mobile solutions are based on use of several stationary base stations and mobile devices with a small shape factor and small power consumption [4].

Advantages of the solution:

- The high level of channel capacity of UpLink/DownLink provides efficient, bilateral data exchange (for example, video of a high traffic definition between the base station and the locomotive).
- Steady radio interface: provides high availability and high efficiency of system.
- Reservation — intended for the complete reservation of system which guarantees the continuous operation of the complex.
- Maintenance — includes the complete diagnostics of system by online radio.
- The wide frequency range of 6 GHz — provides flexibility at radio-scheduling.

Mechanism of monitoring and notification. Depending on distance (or time) when a train approximation to the crossing the analytical system automatically defines whether it has to warn the driver of the train, the operator and people who are on the crossing. So far the train is at the distance more than 2 km that is equivalent to 30 seconds, the driver and the operator can see the situation on the crossing and no notification happens. While at the distance of 2 km and less, the analytical system warns the driver and the operator about the dangerous situation and includes the automatic notification about the coming danger to the people who are on the crossing (Fig. 3).

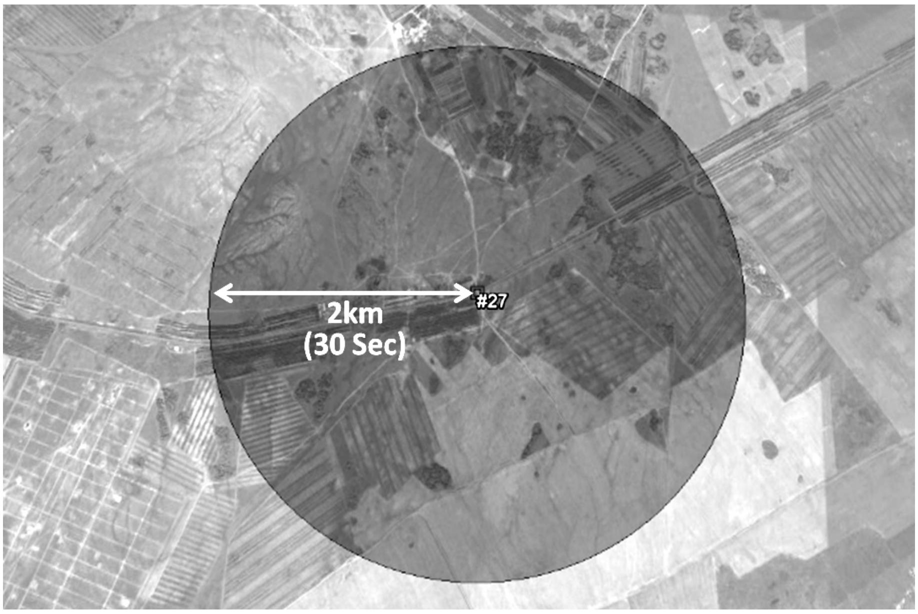


Figure 3. Image on the operator monitor

As shown in Figure 4 the train-driver sees on the monitor, installed in a locomotive cabin, current state on the crossing in real time. The driver sees the GIS (Geographic Information System) card on which the current location of the train is displayed, the image of the approaching crossing in its present state and the real image from the cameras mounted on the crossing (the thermal cell is necessary for extreme conditions, such as fog, rain, snow, etc.) [5].

Figure 4. Image on the driver monitor

New technologies of train traffic monitoring will provide the dispatching personnel with reliable information about all movements of the rolling stock, passengers and freights in real time. Application of satellite technologies will allow to reach a new qualitative level in implementation of the automated train schedule at train dispatchers of Transportation Control Center, to conduct further development and introduction of the perspective systems «Automatic Dispatcher» and «Auto-train-driver».

Besides, coordinate systems with use of the earth-based correcting GPS stations will provide fast and high-quality realization of engineering and geodetic works in projection, construction, repair and content of objects of the Karaganda railroad.

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Темір жолда GPS байланысын қолдану

Қарағанды теміржол қозғалысы қауіпсіздігі мен инфрақұрылымды басқаруды оңтайландыруда қазіргі заманғы серіктес технологияларды енгізу спутниктік навигация, мониторинг және байланыс құралдарын қолдану арқылы магистраль жұмысының ақпараттық-басқару технологиясы кешеніне көшудің негізі болып табылады. Жол геоақпараттық жүйесін құрудың негізгі мақсаты — поезді басқару және қауіпсіздікті, тасымалдау процесін қамтамасыз ету және логистикалық операцияларды, инфрақұрылым күйінің мониторингін, жобалау бойынша инженерлік-геодезиялық жұмыстарды уақтылы өткізу, темір жолдарды құрастыру мен пайдалануды қамтамасыз ету аясында жаңа технологияларды енгізу. Сонымен қатар GLONASS/GPS мониторингі жүйесінің сипаттамасы берілді. Теміржол көлігінің жұмысында бұл жүйені енгізудің негізгі ерекшеліктері көрсетілген. Зерттеліп отырған мониторинг жүйесінің жұмыс істеу қағидасы көрнекілік және құрылымдық сұлбалар түрінде көрсетілген. Жердегі түзететін GPS бекетін пайдаланып, GLONASS мониторинг жүйесін қолдану Қарағандының темір жолының негізгі нысандарының мазмұнында мен жөндеуінде, құрылысында, жобалауында инженерлік-геодезиялық жұмыстарын сапалы және жылдам орындауға мүмкіндік берді.

Кілт сөздер: трафикті басқару орталығы, сымсыз жүйе, мобильді шешім, GPS-мониторинг, ГАЖ картасы.

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Использование GPS связи на железной дороге

Внедрение современных спутниковых технологий в оптимизации управления инфраструктурой и безопасностью движения на Карагандинской железной дороге является основой перехода к комплексным информационно-управляющим технологиям работы магистрали с использованием средств спутниковой навигации, мониторинга и связи. Основная цель создания дорожной геоинформационной системы — внедрение новых технологий в сфере обеспечения безопасности и управления движением поездов, управления перевозочным процессом и логистическими операциями, мониторинга состояния инфраструктуры, инженерно-геодезического обеспечения работ по проектированию, строительству и эксплуатации железных дорог. В статье приводится описание системы мониторинга GLONASS / GPS. Указаны основные преимущества внедрения данной системы в работу железнодорожного транспорта. Принципы работы исследуемой системы мониторинга представлены в виде иллюстраций и структурных схем. Применение системы мониторинга GLONASS с использованием наземных корректирующих станций GPS позволит обеспечить быстрое и качественное выполнение инженерно-геодезических работ в проектировании, строительстве, ремонте и содержании основных объектов Карагандинской железной дороги.

Ключевые слова: центр управления трафиком, беспроводная система, мобильное решение, GPS-мониторинг, карта ГИС.

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