

*railway transport, management systems,  
optimization costs, objects location*

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## GPS SYSTEMS IN TRANSPORT

MOPS Vehicles Monitoring System is designed for monitoring of the exploited means of transport current location in a real time owing to the received location information from GPS satellites and by use of GPRS packet data transmission.

The MOPS system is offered to big companies and business units having a vehicle fleet at their disposal and aiming at minimizing the operation costs of transport units or must make the vehicles location information in the real time available which enables optimal management of their resources.

## SYSTEMY GPS W TRANSPORCIE

System Monitoringu Pojazdów MOPS służy do monitorowania w czasie rzeczywistym bieżącej lokalizacji eksploatowanych środków transportu dzięki informacji o lokalizacji z satelitów GPS oraz wykorzystaniu pakietowej transmisji danych GPRS.

System MOPS jest oferowany wszelkim przedsiębiorstwom i jednostkom, posiadającym flotę pojazdów, które chcą minimalizować koszty eksploatacji środków przewozowych lub muszą dysponować informacją o lokalizacji pojazdów w czasie rzeczywistym, co pozwala na optymalne zarządzanie ich zasobami.

### 1. INTRODUCTION

MOPS system supplies monitoring of any movable objects (vehicles, shipments, etc.) location in a real time.

In version dedicated for vehicles the system supports logistics processes in the range of means of transport usage optimization and exploitation costs management.

An offer for railway companies includes a complex system of rail vehicles (locomotives and carriages) position detection and monitoring in a real time. The system records the run routes with their parameters, enables their later browsing and analysis as well as generating periodic reports, collations and analyses.

The basic elements of the system are: location and transmission module with communications terminal to be installed in a locomotive, electronic identification micro

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modules installed on carriages and portable readers enabling automatic generation of carriage lists of a particular train set.

The system provides the following tools for the logistics services and management units of the Rolling Stock Operator: detailed record of any events accompanying the carriages service ranging from basic information of locomotive and wagon mileage, loads mass, types of loads, lists of train sets, the run routes to other indispensable information necessary in rational operating and repair policy of rolling stock and its management.

Additionally the system enables record of railway teams work time and support of a station operation e.g. technological documents issuance, automatic transfer of information about a train to neighbouring stations and to Dispatcher's Office, automatic documentation of changes in transportation process movement situation and fuel consumption monitoring of diesel locomotives.

## 2. SYSTEM STRUCTURE

**Object location modules (MOPS MG)** installed in vehicles and **supervision centre (SC)** are the basic elements of the system. The supervision centre makes up information subsystem which collects and processes the data transmitted from MOPS MG. The centre may be installed at customer's seat or on WASKO's servers and made available to customer by www. Maps matched to customers individual needs are integral part of the SC. The system allows for position detection and working parameters of the monitored vehicles in a real time and also records all the run routes.

MOPS MG module realises object location, data transmission to SC, data collection from exterior sensors (shock sensor, anti-attack button, switching the vehicle ignition, door opening sensor, float in a petrol tank, temperature and others), outer devices control (horn and alarm switch on). MOPS MG allows for additional modules connection, i.e.:

- MTE-15 – sign terminal (has integrated contactless driver identification module),
- MOPS TC – tachograph impulses reading module,
- MOPS PP – together with a probe constitutes an accurate module of petrol level measurement,
- MOPS TP – temperature measurement module,
- MOPS IK – contact and contactless driver identification,
- MOPS CAN – data read module from CAN bus,
- MOPS EPOKE / SCHMIDT – snow-ploughs and sanding vehicles monitoring module.

Application of the Supervision Centre enables easy access to current and stored data that refer to the monitored objects. Modern and easily accessed technologies allow reliable supervision and communication with vehicles. After having been authorised by use of WWW site (one user may have several accounts defined, each with different rights), each system user may check the data of one or more vehicles of a given fleet and their actual location. The system enables communication with the vehicle as well.

The system is characteristic for interfaces to financial and accountancy systems that enable automatic data acquisition of transport means operation expenses (falling into two accounting: direct materials, car parks, car washes, repairs and spare parts, petrol, amortisation, additional equipment, insurance, taxes, fees, overhaul, re-enterings, etc.).

### 3. COMMUNICATIONS INTERFACES OF MOPS MG MODULE

**GSM GPRS / SMS / CSD** – MOPS MG location module uses GPRS packet transmission to send the data to the supervision centre. The solution significantly reduces the system working expenses and guarantees almost unrestricted functionality. Within the areas where GSM operator does not make resources to GPRS transmission available (mainly low urbanized and abroad areas), the device automatically switches to the transmission course with SMS usage or records data in a “black box” memory and after having restored the coverage the data is automatically sent to the Supervision Centre. GPRS transmission frequency, SMS transmission and a switch between them is configurable.

**Radiotelephone interface** with digital module is an ideal solution dedicated to users who make use of radio communications in everyday work. Thanks to integration with the already existing infrastructure it limits the putting into operation costs and significantly reduces operation costs themselves. It can be especially recommended to uniformed services and public transport companies which have dedicated transmission channels.

Satellite telephones interface is a solution dedicated to particularly demanding customers interested in current information about objects location in places difficult to access and without the GSM network reach or customers who want to become independent of GSM network because of its inconvenience.

### 4. DESCRIPTION OF HARDWARE MODULES INSTALLED IN A VEHICLE

#### 4.1. OBJECT LOCATION MODULES - MOPS MG

MOPS MG location and transmission module installed in means of transport is responsible for collecting information about location and state of the monitored processes and their delivery to the Supervision Centre. The device base is a multifunction microprocessor system integrated with 12-channel GPS receiver and GSM/GPRS communications module. The following are basic data transmitted to the Supervision Centre:

- object geographical coordinates,
- object moment speed,
- measurement date and hour,
- GPS system parameters,
- attack sensor reading,
- shock sensor reading,
- fuel level,
- levels of power voltage,
- digital and analogue inputs states

Frequency of information transmission from MOPS MG to the Supervision Centre is parameterised. Applied communications module makes information transmission by GPRS/SMS/CSD possible. The module is serially equipped with a shock sensor that informs the Supervision Centre about any trials of moving a parked vehicle. It has also been equipped with back-up system that supports the device work for 30 hours after battery disconnection. MOPS MG has RS485 communications interface to enable connection of specialised additional modules.

Using GPRS packet transmission significantly reduces the system operation costs and guarantees unrestricted functionality. Within the areas where GSM operator does not make resources to GPRS transmission available (mainly low urbanized and abroad areas), the device automatically switches to the transmission course with SMS usage.

As a vehicle enters the area without GSM network reach, the module records data in a "black box". At an assumption that enteries are made every minute, the "black box" will be full within 45 days. Each record contains all information collected by MOPS MG and additional modules.

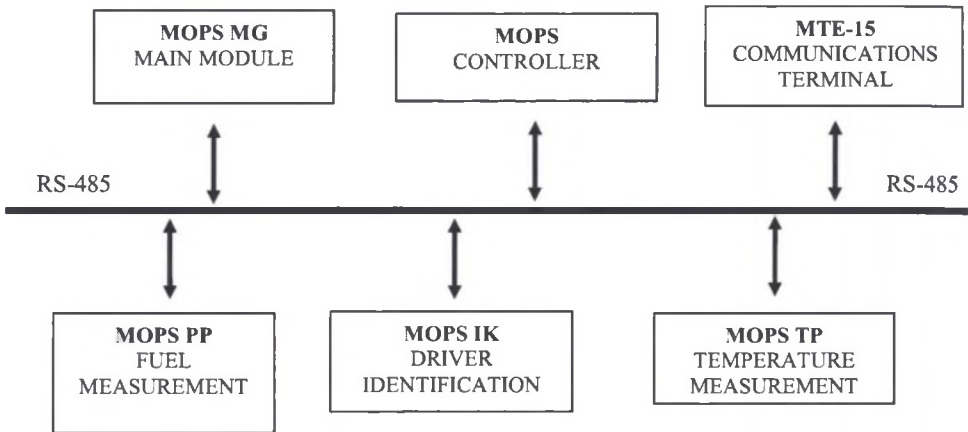


Fig.1. Block diagram system

#### 4.2. SIGN TERMINAL - MTE-15

MTE-15 terminal is a complex device focusing sign terminal functions, tachograph impulses reader, measuring device and peripheral device handler.

The device allows statuses, reports and messages transmission (loading, reloading, duty, fuelling, break-down, etc.) to the Supervision Centre as well as receive of messages, reports and orders sent to mobile objects by SC. The terminal enables connection to sensor series installed in a vehicle. MTE-15 is equipped with interface to connect an external printer and print the received messages. A reader of contactless smart RFID cards is an additional terminal equipment; it enables drivers and staff identification and work time record. The terminal is compatible with any peripherals equipped with RS232 or RS485 serial interface (GPS module, GSM module, a radiophone or a thermoprinter).



Fig.2. Communication terminal

MTE-15 is equipped with a readable LCD display of resolution 128x64 points and „qwerty” alphanumeric keyboard. The keyboard has two programmable special buttons. The adjusted brightness of the screen and keyboard backlighting provides high standard of work both during a day and at night.

The terminal uses several versions of software that is customized to customers diversified demands (e.g. transport units or uniformed services).

#### 4.3. MOPS CONTROLLER

PDA devices of industrial make were used as a controller which reads the identifiers put on carriages and a locomotive. The controllers characteristics:

- increased tightness and mechanical damages resistance,
- built-in RFID passive modules reader,
- besides verification of the vehicles sets made, the module additionally identifies the staff that make the set, the breaks test and last carriage in a set indexing as well as other operations.

The data exchange between PDA device and the Central Database is made by the use of the Rolling Stock Operator telecommunications infrastructure or by MOPS MG transmission module installed on a locomotive.

#### 4.4. CARRIAGE IDENTIFIER

Passive and contactless RFID buttons are used as the rolling stock identifiers put on carriages and locomotives boards (Fig.3.). They are characterised by:

- data record / reading (data concerning carriage, locomotive and shipment),
- unique identification number,
- possibility of work in difficult weather conditions (airtight, resistant housings) – better system accessibility,
- minimum weight and dimensions (50 mm in diameter, 2mm thick) to make the modules assembly easy,



- lack of contact elements – better system reliability and accessibility,
- no need of power supply – unattended.

RFID buttons may be also used as staff identifiers (e.g. traction teams and controllers).



Fig.3. Passive RFID buttons



Fig.4. Active RFID buttons

#### 4.5. CONTACT AND CONTACTLESS DRIVER IDENTIFICATION - MOPS IK

MOPS IK module enables driver identification based on a button with contact interface (Fig.4.) or card / button with contactless interface (RFID) of a unique serial number. The number is attributed to a driver at the Supervision Centre database. Having read the number by identification module, the system automatically assigns all events connected with the vehicle or locomotive (e.g. the run route or stopovers) to a particular driver or engine driver.

The MOPS IK module:

- provides automatic identification of drivers (contact buttons or contactless cards),
- authorises people entitled to drive a vehicle,
- authorises access to additional system module or vehicle (i.e. loading space, access to courier mail, etc.),
- supports automatic generation of technological and consignment documents,
- supports automatic teams work time account.

The identification module works on the basis of “iButton” identification or RFID cards. To perform identification, an identifier must be placed within the reach of a reader. The default configuration of the device makes no effect unless the driver performs identification and starts the vehicle engine. The system is then unable to define a driver and sends only the information about lack of driver’s identification to the Supervision Centre. However the device configuration is possible: should no identification in a given time occur, the vehicle may be immobilized or any other reaction may take place. Lack of identification is signalled by red LED blinking of the reader. Should identification be made correctly, the green LED comes on.

#### 4.6. PETROL MEASUREMENT MODULE - MOPS PP

Petrol measurement module enables:

- precise measurement of petrol level in a vehicle petrol tank,
- measurement of liquid level in tankers and industrial containers,
- analysis of petrol average consumption,
- signalling of assumed petrol consumption standards exceed,
- signalling of stealing fuel from the tank.

MOPS PP is composed of two parts:

- processing module – changes the analogue signal into a digital one and sends the measurement data to MOPS MG main module,
- measurement probe which is individually matched to customers needs and demands.

#### 4.7. TEMPERATURE MEASUREMENT MODULE - MOPS TP

Temperature measurement module makes both vehicle inside and outside measurements possible (e.g. temperature measurement in refrigeration trucks indispensable for food transportation).

Range of temperature measurement:  $-55^{\circ}\text{C} \div +125^{\circ}\text{C}$ ; it may be extended depending on customers needs.

### 5. SCHEDULE OF COLLECTING INFORMATION ABOUT A TRAIN SET

Reading identification buttons from successive carriages and locomotive by the use of controller: the controller should be brought close to a button at about 5-10 cm distance and its key should be pressed.

Possible approval of the made operation by reading an individual identification button of the employee who made the train set.

Data transmission from the controller to the Supervision Centre by the use of MOPS MG module installed in a locomotive.

### 6. SUPERVISION CENTRE APPLICATION

Based on our experience and customers suggestions we have been still developing the range of functions accessible by our software. We treat each customer individually. When defining the application functionality, the customer may chose a group of functions, collations, charts and monitored sensors he is interested in. WASKO created a dedicated application of advanced functionality that involves functions to support the processes that appear in transportation and forwarding companies. WASKO's Supervision Centre offer for communal and public transport companies was extended by special function groups which are

characteristic for their operation specification. Equipment and program modules were extended by functions that support the activities present in a railway carriage process.

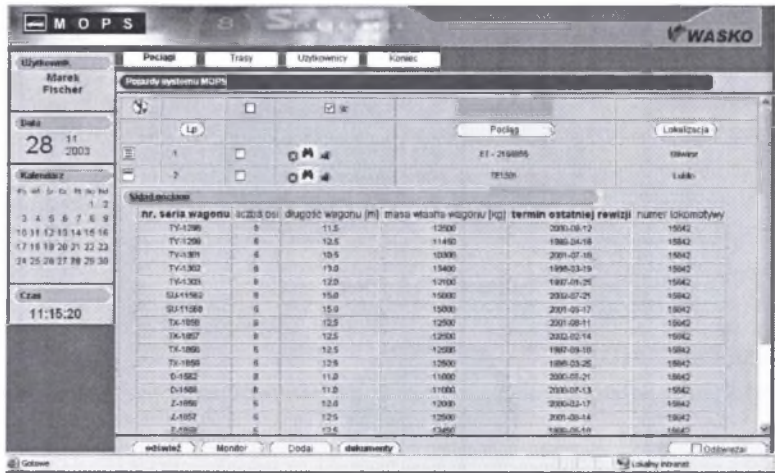


Fig.5. Application main look

6.1. LOCOMOTIVES AND CARRIAGES DATABASE

All information collected in a system and referred to current sets location (i.e. geographical location, momentary speed, height above the sea level, etc.) are recorded in the system central database which involves the following:

- record information about a given train set (i.e. numbers of carriages in a set or occurrence of special carriages),
- record information about engine drivers and their work time (i.e. work start and finish times),
- information generated on technological documents (i.e. sets weight, breaks condition, forwarding and target stations),
- trains timetables,
- information about carried cargoes (waybills numbers and NHM international codes),
- record information about locomotives and carriages (i.e. number and amount of axes, kerb weight, revision date, etc.).

The database is supported from the following sources:

- sets location and content of sets together with work time record by means of author device using GSM technology (the sets content is read by a hand terminal),
- record of consignment letters made cyclically: once or several times a day,
- staff's record made cyclically from the company record system or directly entered from MOPS system level,
- rolling stock record made once while the system implementation and subsequently at authorised user's request,
- trains timetable – data import is performed should the need arise e.g. once a year.



Data base management system is selected according to:

- customer preferences and software licenses held,
- the range of system implementation (amount of the system users and the range of collected data).

## 6.2. DATA PROCESSING

The data of train set composition comprising information about all carriages and engine drivers work record feed the system at the moment of train setting, receiving the train at a target station and at any manoeuvre station or marshalling yard where the set state is changed. The information lets among others on:

- generation of technological documents and operation reports,
- monitoring and reporting of engine drivers work time: generation of relevant reports and statistics.

Train sets location data is collected up-to-date and its amount depends on assumed frequency of restoring location information. Among other things the data allows:

- current sets location monitoring (text information about town, visualisation on a digital map, information about momentary speed, etc.),
- train set information transfer to neighbouring stations (notification about approaching trains),
- getting collective information about train sets at a given area (region or station),
- generation of train courses regularity charts,
- getting information about train traffic at crossing the indicated checkpoint,
- access to the run routes history – statistical information of the run route (e.g. time, average speed etc.) and visualisation of the route on a digital map.

The data including information about the shipments (waybills) is downloaded automatically from shipment record system; it is made cyclically (e.g. once every 24 hours). Among other things the information allows:

- following the route of a particular shipment and making the service available to customers,
- generation of reports and amount statistics about shipments.

The rolling stock record data includes information about scheduled examination which are imported from railway record system on system authorised user's demand (i.e. head dispatcher). The information enables among other things:

- rolling stock record storage and update,
- generation of alerts (reminders) about activities connected with the rolling stock (e.g. an inspection),
- generation of the rolling stock operation statistics.

The data includes information of train sets timetable and feed the system while the timetable actualisation. The information allows among other things:

- timetable presentation,
- comparison of current course with the timetable and reports generation.

### 6.3. DATA PRESENTATION

A three-layer architecture designed to store application in a central server makes the application use possible without any software installation; no updating is needed either.

Customer terminals enable the system access by Internet explorer being which is a standard equipment of PC computers.

Owing to planned three-layer system operation model:

- dispatcher or inspector at the station level,
- exchange at the region level,
- dispatcher exchange at main dispatcher's office

it is advisable to equip the application with users management module including a precise mechanism of access allocation to specific data, its modification and verification as well as to the system functions.

### 6.4. ROLLING STOCK RECORD MODULE

The module stores and makes accessible to its users in the form of collations the rolling stock filing data, the object condition (e.g. repairs and maintenance dates, etc.), belonging to a set and goods information.

Informacje o lokomotywie: 21560554

☐ Dane ogólne

Nazwa: ET-21560554      Rocznik: 1992

Typ obiektu: Lokomotywa

☐ Dane systemu MOPS

☐ Informacje dodatkowe

☐ Stan pojazdu

☐ Data następnego przeglądu: 2004-06-26      Dodaj przegląd

☐ Informacje dodatkowe:      Dodaj informację

Fig.6. Rolling stock record module look

### 6.5. ROUTES REGISTRATION MODULE

The module presents information about a completed route, speed charts, engine drivers data in bar charts and preview of the route on a map with the possibility of recorded route penetration.

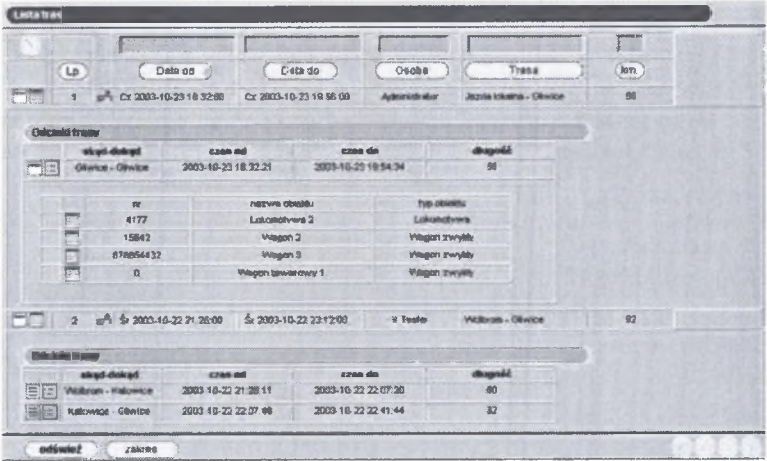


Fig.7. Routes registration module look

6.6. VISUALISATION MODULE

The module enables preview of current sets location on a digital map together with momentary speed information accurate within a specific delivery. Both current location and history of monitored objects routes are displayed on multilayer digital map. Together with integrated database it is a basic tool of the Supervision Centre operator.

The module allows for any configuration of presented data range and enables single objects and the whole fleet monitoring simultaneously.

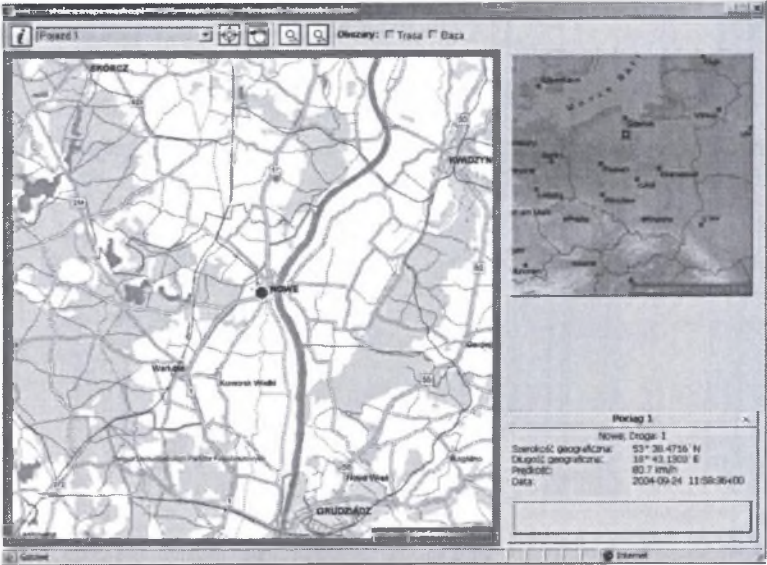


Fig.8. Location visualisation module look

### 6.7. STAFF MODULE

The module presents the analysis of recorded work time together with corresponding reports in the form of text and graphic collations. Work inspection involves among other things:

- current location,
- number of worked hours,
- number of hours to be worked,
- daily and weekly driving and work limits,
- driving time and stopover time,
- the run route.

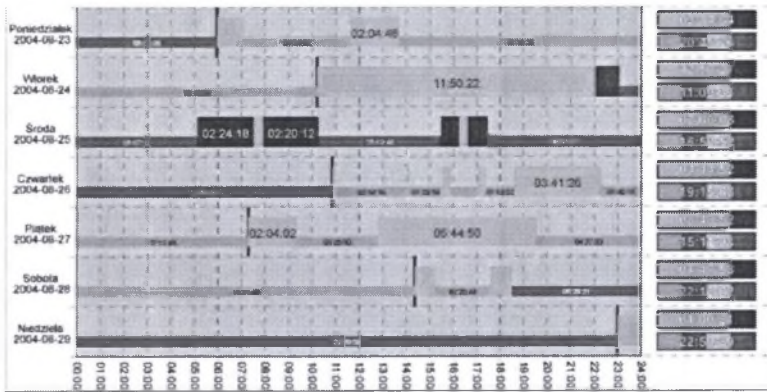


Fig.9. Work time analysis module look

### 6.8. DOCUMENTS' MODULE

The module collects and makes available to customers the required technological documents that are printable; the documents are associated with objects (sets) they refer to.



KARTA PRÓBY HAMULCĄ

1. Próby hamulca dokonano w czasie postoju

1. błąd

masa hamulca nieprawidłowa

2. Data brak

3. Numer pociągu pusty

4. Próba dokonana z:\*)

---

b) innego pojazdu trakcyjnego

c) sieci stałej sprzężonego powierza

5. Masa brutto pociągu brak ton

6. Masa hamująca wymagana brak% brak ton

7. Masa hamująca rzeczywista brak ton

8. Numery wagonów z wyłączonym hamulcem

---

9. Numer ostatniego wagonu brak

10. Ciśnienie powietrze w przewodzie ostatniego wagonu brak

brak

(poziór wskaźny dołączający próby)

brak

(poziór maszynowy)

Fig.10. Technological document look

6.9. USERS MODULE

The module allows assignment of rights to the required system functions and to the required data depending on user’s official duties range.

Użytkownicy			
Lp	Nazwisko	Imię	Nazwa
1	Adamowicz	Patryk	1 Adamowicz
2	Adamowicz		Adam
3	Adam	Adam	Adam
4	Adam	Adam	Adam
5	Adam	Adam	Adam
6	Adam	Adam	Adam
7	Adam	Adam	Adam
8	Adam	Adam	Adam
9	Adam	Adam	Adam
10	Adam	Adam	Adam
11	Adam	Adam	Adam
12	Adam	Adam	Adam
13	Adam	Adam	Adam
14	Adam	Adam	Adam
15	Adam	Adam	Adam
16	Adam	Adam	Adam
17	Adam	Adam	Adam
18	Adam	Adam	Adam
19	Adam	Adam	Adam
20	Adam	Adam	Adam
21	Adam	Adam	Adam
22	Adam	Adam	Adam

Fig.11. Users’ module look