INTRODUCTION

There is a possibility of event data recorder (EDR) to integrate the functions of monitoring vehicle's behaviour prior to the accident, during the crash and after the crash to the current or developed motor vehicles systems, for the purpose [13]:

– Create an instrument for support to make clear specific road accident (chain accident, etc.);
– Make easier the guilty and innocence clarification;
– Make easier the process of insurance event liquidation;
– Increase the active safety (psychological subconscious of driver about the possibility to documentation behaviour of vehicle);
– Increase the process of legislation to embed system in vehicles (e.g. in police, fire brigade vehicles, driver's school).

EDR - “black box” is a device in a vehicle that stores event-specific data, e.g. vehicle speed and driver inputs when a crash, rollover, or other mishap occurs [18].

EDR means a device or function in a vehicle that records the vehicle’s dynamic, time-series data during the time period just prior to a crash event (e.g. vehicle speed vs. time) or during a crash event (e.g., delta-V vs. time), intended for retrieval after the crash event [9, 10].

Some authors called mentioned device as the deck recorder of vehicle movement parameters which registers some characteristic data describing the state of the vehicle performing the transport task. The idea behind applying recorders is to determine circumstances on the route where events (collisions, accidents) happened [11, 12].

EDR is a deck recorder of events which in case of an accident or any event registers and saves data describing the movement of the vehicle (speed, acceleration, using the brake etc.) before, during and after the event occurred [3].

Technical investigations following an accident can bring a valuable return in terms of experience which is useful for the future development of safety in road transport. The European Commission will examine to what extent the principles and methods applied in the other modes of transport for technical investigations after accidents could be transposed to the field of road transport, taking into account the specific character of the latter ). The added value of developing and installing event data recorders (‘black boxes’), in particular on professional vehicles, will be examined taking into account the socio-economic impact [2].

Calls on the Commission to submit a legislative proposal, including a timetable and a detailed approval procedure, by the end of 2012 providing for the phased introduction, initially in rented vehicles and subsequently also in commercial and private vehicles, of an integrated accident recorder system with a standardised readout which records relevant data before, during and after accidents (‘Event Data Recording’); stresses, in that connection, the need to protect individuals’ personal data and to use the data recorded exclusively for accident research [5].

European Transport Safety Council (ETSC) would encourage the wider use of Advanced Driver Assistance Systems and avoidance systems which could be used to document the real-work effectiveness of different measures. ETSC would also welcome progress on in-vehicle Event data
recorders (so called “black box”) devices, which record vehicle situation before and during any accident. Event data recorders offer first hand information about the safety systems available on the vehicle and their operation. Additional information could include speeding, measures of crash severity and vehicle manoeuvres. ETSC promote wider use of in-vehicle Event data recorders [6].

Mr Cornelis de Jong (NL), speaking on behalf of the EUL/NGL group, at EC forum, stressed that also insurance companies had an interest in the information on accidents, and there were many other commercial applications in the making. For the police the "spy" box would also be of interest [4].

Organisation for Economic Co-operation and Development (OECD and European Conference of Ministers of Transport (ECMT) [26] addressed the issue of how journey data recorders might be employed to reduce young driver risk and concluded that economic incentives such as lower insurance premiums could be employed to encourage their use. In addition it was suggested that parents might be able to insist that certain technology be placed in vehicles used by their children.

1 CHARACTERIZATION OF EVENT DATA RECORDER – BLACK BOX

1.1 The benefits of black box

The number of fatal road accidents’ victims in European Union was reduced (Fig.1) from 54,000 in 2001, 45,400 in 2005, 31,000 in 2010, and nearby 26,000 in 2013 [22].

The European Commission (EC) adopted an ambitious Road Safety Program which aims at cutting road deaths by half by 2020. The program sets out a mix of initiatives, at European and national level, focusing on improving vehicle safety, the safety of infrastructure and road users’ behaviour.

The statistics are invariably devastating for Poland, which with respect to the number of victims and mortality in the road accidents is always at the end of the list. The threat of death in the road accident in Poland is three times higher than in the rest of EU countries, and in the statistics of the fatalities per 100 accidents Poland is even worse than Lithuania. For Poland this number is 10.3, in Lithuania – 9.9, Greece – 8.8, while the average in the EU is 3. In this context, a shockingly low mortality coefficient is noted in such countries as Germany and Great Britain – 1.4, as well as in Austria – 1.7 or Italy and Sweden – 1.9 [24]. The probability of death of the accident victim in Poland is, on average, four times higher.

Moreover, in the statistics concerning the number of people killed per 1 million inhabitants we also hold last place, since the EU average in 2013 was 55, while in Poland – 87, the last place was taken by Romania – 92.

The event data recorder (EDR) can meet the above mentioned requirements and improve the level of transport safety with the reduction of death number and accident reconstruction. EDR records events which, in case of an accident or any event, registers and saves data describing the movement of the vehicle (speed, acceleration, using the brake etc.) before, during and after the event occurred [3,
One of primary tasks of accident reconstruction is to determine the values of the event participants motion parameters prior to its occurrence. The correctness of their behaviours is assessed on their basis, and then the court makes a decision whether the event participants are guilty or innocent. One of frequently encountered tools, which are useful to determine the values of the aforementioned parameters, is a device recording some selected parameters of vehicle motion. They are so called EDR or just the car ‘black boxes’, device used for accident reconstruction [7].

EDR provides a powerful tool to improve driving standards and reduce crash rates. EDR has the potential to provide a wide range of safety benefits, including [27]:

- relatively inexpensive and continuous measurement of driving behaviour and vehicle condition use, which is otherwise difficult to observe,
- a tool for employers to monitor and assess their staff who drive for work, improve safety, reduce crash rates and operational costs, meet their legal obligations and reduce the risk of prosecution or civil action,
- more accurate and objective data about driving than, for instance, responses to self-reported,
- a way to help young, novice drivers, parents and licensing authorities to monitor and improve the driving of young, novice drivers,
- a method for insurance companies to differentiate between drivers based on their risk, rather than just by gender or age, and to tailor their insurance premiums accordingly,
- a powerful research tool to enable the collection of large amounts of real-life, natural driving behaviour and the effectiveness of safety interventions on that behaviour,
- a tool to inform further training and guidance needs,
- Data to help highway authorities to identify problem locations on their road network.

### 1.2 General characterization of black box and projects

The first EDRs or black boxes were used in the aviation industry in late 1950s. In 1958, the Federal Aviation Act and corresponding regulations issued by the Civil Aeronautics Administration (the predecessor of the Federal Aviation Administration) made the use of black boxes or flight data recorders mandatory for commercial aircraft. In 1976, National Transportation Safety Board (NTSB) issued regulations requiring the use of EDRs in commercial marine vehicles. In May 1995, the Federal Railroad Administration issued regulations requiring EDRs on heavy rail transportation. While the use of EDRs in automobiles and light trucks is currently voluntary, vehicle manufacturers such as General Motors and Ford have installed EDRs in many of their newer models [9, 10].

The recorder proposed by the Motor Transport Institute, to a large extent, may help reduce the number of accidents, significantly shortening the travel time and energy consumption, thereby improving the quality of the environment, and will be useful as evidence in the disputable matters.

The proposed recorder - car black box, can be used to record data concerning technical conditions of the vehicle, driving technique, and drivers’ compliance with traffic rules and road traffic safety in the following cars:

- passenger, service and privileged cars – will allow the registration of the earlier indicated data and will provide evidence in case of accident,
- buses and taxis – apart from the recorded data, it will help ensure the safety of the driver and passengers, will enable the location of vehicles in the event of theft,
- trucks - will ensure registration of the data on technical condition will enable the localization, will contribute to the reduction in the number of accidents and ensuring safety of the driver.

SAMOVAR Project [20] was developed within DRIVE II program. The standard focuses on low cost in-vehicle electronic systems for recording data related to vehicle and its communications to other systems and Databases. A SAMOVAR system will comprise a central interface that integrates several sub-systems, as needed by any vehicle or fleet operator. The complete system will include any of the following functions: monitor and record vehicle system parameters, monitor and guide a driver’s performance or condition, warn a driver of unsafe vehicle, driving or environment, advise a driver of location, route, other information, detect and record details of an accident.
European Commission Directorate-General for Energy and Transport developed a project of vehicle event recording based on intelligent crash assessment - Veronica I and Veornica II [21].

VERONICA II is to specify the technical and legal requirements for a possible implementation of Event or Accident Data Recorders in vehicles in Europe. The definition of trigger sensitivity is of major importance in order to capture not only hard crash data but also data from collisions with 'soft objects', i.e. vulnerable road users who represent a relevant part of road users and victims in accidents.

EDR data will be used not only to improve accident investigation and accelerate court procedures but also for enhanced research with in-depth data bases as these data provide real-life information on the vehicles' and drivers' actions, immediately before the crash.

Research based on enhanced real-life data will allow for better evaluation of road safety measures in all fields: active and passive vehicle safety, infrastructure, training, regulation and enforcement.

With regard to research with EDR data there are two options for European action in the field of in-depth data bases:
- addition of a new in-depth chapter to CARE by means of a new or an extended mandate,
- coordination of research with dispersed national data bases, possibly under the ERSO umbrella.

The requirements referring to frequency/range, accuracy, resolution and phases are fulfilled by the NHTSA standard. A large number of signals to be fed into EDR are already standardised according to SAE J1939-71 standard.

The EDR should be able to download data from digital tachographs. This allows a complete record of activities to be obtained for drivers and vehicles. In addition, the digital data offers many opportunities for monitoring driver activities and evaluation to support improved fleet management.

PC NET Service with Motor Transport Institute developed in 2008 TachoScan solution for analyzing data from digital tachograph can generate driver's general report, which shows distance, working hours, waiting hours and rest hours, start and stop work hours per day for individual driver.

Furthermore Motor Transport Institute with Signal Institute and Automex from 2009 to 2011 developed the project NR10 0016 06 refers eCall system. The system is based on 112 emergency call. The call is made automatically by the car as soon as on-board sensors (e.g. the airbag sensors) register a serious accident in the car; or it is done manually. Voice plus minimal set data (MSD) is send to relevant PSAP (Public Safety Answering Point). During the project, the simulator of eCall unit was developed consisting of accident detection module and transmission module to PSAP.

The International Congress on European Association for Accident Research and Analysis (21 EVU, Brasov, Romania 2012) developed the main topics of accidents of two wheel vehicles (reconstruction and safety), human factors in road accidents (also in relationship with active safety systems) and the use of data from EDRs in reconstruction. The EVU is a pan-European association of experts in the field of accident research and reconstruction.

During the conference, two authors: Spek and Bot [23] presented data of the total of nine modern cars crashed in five high speed crash tests. Up to and into the crash, the engines were running. Data communication on the drive train CAN bus was monitored during the crash, and evaluated in order to assess the integrity of speed messages within the crash. Both freeze frame data and EDR data, if applicable, were captured after the crash. The data was compared against the measured pre-crash speed.

2 REQUIREMENTS OF EVENT DATA RECORDER – BLACK BOX

2.1 Legislation and standardization requirements of black box

Event data recorder should be interoperable. Interoperability means the ability of the system or device to safely and without interruptions transfer data, which can reach certain size required for a given network, determined in the standards [15, 16]. Interoperability within the European Union should be ensured at the technical, conventional and procedural level, assuming that there have been actions designated for the European Union, aimed at achieving it, and which are conducted both in the form of joint undertakings, and independent actions of the individual member states.
In order to ensure coordinated and effective implementation of EDR in the area of the entire EU, it is necessary to introduce specifications, including – in the appropriate cases – standards defining detailed regulations and procedures.

The US National Highway Traffic Safety Administration – NHTSA [17] required from the manufacturers who install EDRs to include a minimum standard set of data to be recorded: at least 15 types of crash data including pre-crash speed, engine throttle, brake use, measured changes in forward velocity, driver safety belt use, airbag warning lamp status and airbag deployment times [30].

NHTSA wants to reconstruct what most vehicles do:
- Use pre-crash data to obtain travelling speed before braking, prior to impact – especially when ABS braking does not leave clear road evidence of braking.
- Use driver throttle and brake inputs to gain insight into driver’s intent & causation.
- Use Delta V data as a check on momentum analysis or crush analysis for what happened during impact.
- Challenges to establish probable causes of accidents warrant EDRs becoming more common.

The data collected and registered by EDRs reflects accident status but also technical status of the vehicle (fuel consumption, airbag functionality), but they will also register and describe (directly or indirectly) driver’s behaviour in a dynamic way, e.g., brake fluid pressure at the beginning and the end of braking, vehicle speed, including that during braking, engine speed, throttle percentage, using or not using safety belts [31].

Based on agreements with mobile service providers, EDRs are linked to onboard communication systems, which transmit the relevant information to a remote location when the event occurs. A collision notification system (or in-vehicle emergency call system) can, therefore, be activated automatically or manually and provide data to emergency services. Initiatives have been launched in the US and in the EU to promote the implementation of such systems and to enforce standards across the different transport sectors and applications. Section 31406 of Senate Bill 1813 has stated EDR as mandatory and it must be installed in all cars in USA starting with 2015, and outlined civil penalties against violators.

European Commission determined a quantitative target: 50% reduction of the number of road fatalities by the 2020, starting from 2010 [28]. EC decided (Recommendation of 8 September 2011) to equip all cars with an on-board system and ensure the implementation, of the mechanism serving the eCall reporting indicator by the mobile networks’ operators in their networks by 31 December 2014 [2].

Minimum set of data means information that must be sent to the entry point for reports of accidents in accordance with EN 15722 standard. Successful implementation in the entire EU of a harmonized interoperable eCall service requires automatic transfer of voice and audio connection and the minimum data set of the accident, generated by the on-board system, to appropriate public accidents reporting exchange.

Member States should commit its national authorities to notify the Commission, by the end of March 2012, about the measures that were applied in response to this recommendation. Furthermore, according to European Parliament resolution of 27 September 2011 on road safety in Europe for the years 2011 to 2020, there should be following legislative document developed [5] by 2013 - proposals for legislative changes, assuming that each new vehicle must be equipped with a system reminding about fastening seat belts in the front and rear seats, operating on the basis of acoustic and visual signal.

According to EC statement, EDRs would reduce probability of deaths as well as for serious and light injuries [2], as a result of a collision, by 20%. For the reasons mentioned, the EC recommends eCall pan-European system for the EU [25].

The Research and Technological Development Framework of the European Union launched a large number of EDR projects which have been finalized or are still carried out with a view to enhance the road safety. Another study based on available practical experiences of EDR concludes that a reduction in the number of accidents by 20% would generate a reduction of 26, 1% of lightly injured, of 36, 9% of seriously injured and of 50, 4% of killed road users [1].
There is evidence that drivers who know that their cars have black boxes drive more cautiously. Case studies from Europe and the US show that the number of crashes can be reduced by 20 to 30 percent [1]. Crash severity is also reduced. Berlin Police Department reports that deaths, as well as serious and light injuries are reduced by 20% in the crashes of vehicles with EDRs. As a result, all Berlin Police radio patrol cars use EDRs. A similar trial in Vienna led to the use of EDRs in all the city’s police cars. In mid-nineties, a Europe-wide program studied the effect of different types of EDRs in fleets in Great Britain, the Netherlands and Belgium. The overall crash rate fell by 28% and costs by 40%.

German parliament, the Bundestag in November 2012 backed a proposal to the European Commission to put black boxes, which gather information from vehicles involved in accidents, in all of the country’s new cars from September 2015 [32]. German ministry for traffic, the Verkehrministerium, lent its support to the proposal after details of the motion emerged this week. German council for road safety — which advises the ministry for traffic — is now in the process of setting up a taskforce to evaluate the black boxes.

Berlin police’s experience by bears this out: since the city's police cars had the boxes installed in 2010, accidents involving the vehicles dropped by 35 percent.

### 2.2 Functional requirements of black box

The device will receive data from selected circuits of the vehicle via digital and analogue input ports. Sensors may be possible to be connected e.g. to the doors, lights, turn indicators or brakes.

EDR should be installed in protected place. This kind of place is vehicle cabin, but optimal place is the area under driver’s seat (Fig. 2).

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**Fig. 2.** Installation place of EDR and camera (own study and work)

EDR should be in line with all specifications (environmental, physical and electromagnetic compatibility). Currently, professional organizations have developed standards for vehicle EDRs used in commercial and passenger vehicles, as follows [10, 14, 17, 19, 29, 30]:

- **EN 60950-1:2007/A1:2011.** Information technology equipment – Safety – Part 1: General requirements/ Application of a safety standard is intended to reduce the risk of injury or damage due to the following: electric shock; energy related hazards; fire; heat related hazards; mechanical hazards; radiation; chemical hazards;
- **IEEE 1616 standard in September 2004.** The document defines a minimum standard for onboard crash recorders for all types of highway vehicles including passenger cars, light trucks, heavy trucks, and buses. The standard now includes a data dictionary of 86 data elements. Amendment 1: Brake and Electronic Control Unit (ECU) Electronic Fault Code Data Elements;
- **ISO/TC22/SC12/WG7 - International Organization for Standardization (ISO).** The scope of the ISO/TC22/SC12/WG is to establish standardized methodologies for traffic accident analysis. The use of EDR technologies and the various data that can be extracted from EDRs is under review by this working group;
- **SAE J1698 standard.** The document defines a common format for displaying and presenting crash-related data recorded and stored within certain electronic components currently installed in many
vehicles. J1698/1 - Vehicle Event Data Interface Vehicular Output Data Definition (December 2003), J1698/2 - Vehicle Event Data Interface-Vehicular Data Extraction (May 2004);
- SAE J2728in June 2010. The document describes common data elements and data element definitions for heavy commercial vehicle event data recording. The standard specifies event triggers, threshold levels, and survivability. The committee will also recommend procedures for data extraction;
- SAE J1939-71 in 2013. Vehicle Application Layer is the SAE J1939 reference document for the conventions and notations that specify parameter placement in PGN data fields, the conventions for ASCII parameters, and conventions for PGN transmission rates. This document previously contained the majority of the SAE J1939 data parameters and messages for information exchange between the ECU applications connected to the SAE J1939 communications network.

The electronic system will record and remember the course of acceleration during the collision and remember the result of changing the vehicle speed. In addition, it will remember certain information prior to the accident and immediately after the accident. Every car has got many sensors to monitor conditions. The actual sensors in car were presented in Fig. 3.

The device will interpret digital information transmitted on the CAN bus and the FMS-CAN to record the following parameters (range, depending on the type of vehicle and equipment, such as truck equipped with a tachograph): speed, engine rpm, the position of the brake pedal, clutch pedal position, accelerator pedal position, the state of the cruise control, fuel level, mileage, total fuel consumption, tachograph - operation mode, tachograph - speed, tachograph functioning, dealing with the event status, the mileage remaining until the next tests, engine hours, coolant temperature, the axis load.

**Fig. 3.** Monitoring sensors in vehicle [11]

CAN bus (Controller Area Network) refers to vehicle bus standard, developed by Robert Bosch, which had quickly gained acceptance in the automotive and aerospace industries. CAN is a serial bus protocol to connect individual systems and sensors as an alternative to conventional multi-wire looms. It allows automotive components to communicate on a single or dual-wire networked data bus up to
1Mbps. The protocol was Publisher in 1986 at the Society of Automotive Engineers (SAE). Bosch published the CAN 2.0 specification in 1991. CAN bus is one of five protocols used in the OBD-II (On-board diagnostics) standard. The OBD-II standard has been mandatory for all cars and light trucks produced in the United States since 1996, and the EOBD (European onBoard Diagnostics, regulations are the European equivalent of OBD-II). EOBD is a system for warning the vehicle driver that there is a fault which may cause the emission levels to exceed those allowed by the European directive. EOBD standard is mandatory for all M1 vehicles and petrol vehicles produced in European Union since 2001 and all diesel vehicles produced since 2004.

Fleet management system (FMS) - the mission of six major European truck manufacturers was the creation of a standard to make the surveillance of a fleet over the internet possible. The main problem was the mixture of trucks from different manufacturers in a fleet. FMS can be seen as an interface between truck and internet data transmission. FMS uses a physical layer according to ISO 11898-2 (250 Kbit/s), an application layer according to SAE J1939/71 and a data link layer according to SAE J1939/21. The physical connectors are not yet standardized.

Additional sensors will be able to monitor: the time of release (reaction), a longitudinal, lateral acceleration, vehicle speed (the counter), the engine throttle (gas pedal), brake status (enabled or disabled), supply voltage, the position of the ignition, cushions signalling, the number of events, the time between events, horn, light switches, traffic lights, parking lights, turn indicators, the change in the car deflection (car rotational speed with respect to the vertical axis), the driver's seat belt status, events registration time (Tab. 1).

Tab. 1. Requirements refer registration data based on VERONICA project [21]

<table>
<thead>
<tr>
<th>Data element number</th>
<th>Data element</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trigger Date Time</td>
<td>Resolution: 1 ms; Accuracy: +/- 60 s</td>
<td></td>
</tr>
<tr>
<td>2. Longitudinal acceleration</td>
<td>Resolution: 0.16 m/s² (0.016 g); Accuracy: ± 5%</td>
<td></td>
</tr>
<tr>
<td>3. Lateral acceleration</td>
<td>Resolution: 0.16 m/s² (0.016 g); Accuracy: ± 5%</td>
<td></td>
</tr>
<tr>
<td>4. Lateral acceleration (IP)</td>
<td>Resolution: 1 m/s² (0.1 g); Accuracy: ± 5%</td>
<td></td>
</tr>
<tr>
<td>5. Longitudinal acceleration (IP)</td>
<td>Resolution: 1 m/s² (0.1 g); Accuracy: ± 5%</td>
<td></td>
</tr>
<tr>
<td>6. v (Speed, vehicle indicated)</td>
<td>Resolution: 1 km/h; Accuracy: ± (3% + 1km/h)</td>
<td></td>
</tr>
<tr>
<td>7. Engine throttle, percent full</td>
<td>Resolution: 0.01; Accuracy: ± 5%</td>
<td></td>
</tr>
<tr>
<td>8. Brake status (Service brake, on, off)</td>
<td>Resolution: On or Off; Accuracy: N/A Remarks: Time accuracy has to be within (+/- 20msec).</td>
<td></td>
</tr>
<tr>
<td>9. Ignition cycle, crash</td>
<td>Resolution: 1 cycle; Accuracy: ± 1 cycle</td>
<td></td>
</tr>
<tr>
<td>10. Ignition cycle, download</td>
<td>Resolution: 1 cycle; Accuracy: ± 1 cycle Remarks: Data set is only provided to the download interface if an event is stored in a slot.</td>
<td></td>
</tr>
<tr>
<td>11. Frontal air bag warning lamp, on, off</td>
<td>Resolution: On or Off; Accuracy: N/A Functional test should be defined by ISO group.</td>
<td></td>
</tr>
<tr>
<td>12. Frontal air bag deployment, time to deploy/first stage, driver</td>
<td>Resolution: 1 ms; Accuracy: ± 2 ms Functional test should be defined by ISO group.</td>
<td></td>
</tr>
<tr>
<td>13. Frontal air bag deployment, time to deploy/first stage, front passenger</td>
<td>Resolution: 1 ms Accuracy: ± 2 ms Functional test should be defined by ISO group.</td>
<td></td>
</tr>
<tr>
<td>14. Multi-event, number of events (1, 2, 3)</td>
<td>Functional test should be defined by ISO group.</td>
<td></td>
</tr>
<tr>
<td>15. Time from event 1 to 2</td>
<td>Resolution: 0.1 s; Accuracy: 0.s s</td>
<td></td>
</tr>
<tr>
<td>16. Horn</td>
<td>Resolution: On or Off; Accuracy: N/A Remarks: Time accuracy has to be within (+/- 50msec).</td>
<td></td>
</tr>
<tr>
<td>17. Main beam</td>
<td>Resolution: On or Off; Accuracy: N/A</td>
<td></td>
</tr>
<tr>
<td>18. Dip beam / low beam</td>
<td>Resolution: On or Off; Accuracy: N/A Remarks: Time accuracy has to be within (+/- 50msec).</td>
<td></td>
</tr>
<tr>
<td>19. Parking lights</td>
<td>Resolution: On or Off; Accuracy: N/A Remarks: Time accuracy has to be within (+/- 50msec).</td>
<td></td>
</tr>
<tr>
<td>20. Indicator</td>
<td>Resolution: On or Off; Accuracy: N/A Remarks: Time accuracy has to be within (+/- 50msec).</td>
<td></td>
</tr>
</tbody>
</table>
23. **Technical requirements of black box**

One element of accident reconstruction is the recreation of time-space relationships of the event participants. Motion reconstruction process is based on the analysis of records of the parameters characterizing the motion of the car body. The forward motion is recorded as standard in a form of linear acceleration components (components: longitudinal, lateral, and vertical).

The device is designed for installation in all types of vehicles (passenger cars, trucks, buses) to record the driving parameters such as speed, acceleration, braking, use of direction indicators, etc. Such information can be extremely helpful in identifying those responsible for road accidents and will allow reconstructing the accident. They are also to replace the witnesses who are not always reliable.

The recorder will have a small size, will be much smaller than the car radio, and made of durable materials, and the place specially protected in it should be the SD card casing, on which the data will be stored (Fig. 4).

**Fig. 4. On-board vehicle, event data recorder functional structure (own study and work)**

For safe and reliable operation of all electrical and electronic equipment in the car, it is necessary to ensure the electromagnetic compatibility of the recorder - the black box. The device should be compatible with all environmental specifications, physical and compatibilities defined in the CEN, ISO and ETSI standards. It should meet all requirements, relating to this group of products, of the EU Council Directives, European standards and national legal regulations.
CONCLUSIONS

Authors propose two devices of event data recorder (EDR): the economic, universal simple event data recorder - black box, the economic, universal event data recorder - black box for all types of vehicles, taking into account the eCall reporting.

Recorder – a car black box can be used to record data concerning the technical condition of the vehicle, the driving technique, and the driver’s compliance with the traffic regulations and maintaining the road traffic safety in all motor vehicles.

European Commission is currently considering the implementation of legislation in this area, prescribing mandatory installation of black boxes in all vehicles. Psychological impact of the black box will revolutionize road safety. Drivers will be more cautious, knowing that their every manoeuvre may be recorded, so in the event of an accident they will not be able to make false statements.

The device, connected to vehicle monitoring sensors, will be installed behind the dashboard or under the driver’s seat. Each sudden change of speed or opening of the airbag will activate it, so that also the collisions involving pedestrians are be recorded. The machine will automatically alert the emergency road services about the accident. In Britain, black boxes are standard equipment in many privileged vehicles. When in 1999 the London police installed them in a 3.5 thousand of company cars, within 18 months, the costs of road accidents fell by 2 million pounds. The devices are also placed in some newer car models.

In the U.S., black boxes are quite commonly used, and right now they belong to a standard equipment of over two thirds of new cars. U.S. Senate approved the bill, under which from the 2015 on all new vehicles must be equipped with digital driving parameters recorders, known as black boxes. The failure install such equipment will result in punishment.

The studies conducted in the U.S. and the UK have shown that drivers who drive with black boxes, were 20% less likely to have participated in the fatal cases, the failure rate and repair bills for their cars fell by 25 percent. In Poland, the annual cost of road accidents alone are 5 billion, so if that gets reduced by about 20%, one will get the savings for the state – amounting to 1 billion annually.

Abstract

The paper refers problems of reduction in the number of accidents by driver behaviour monitoring using event data recorder, called EDR - black box for all types of the motor vehicles. The device can record data concerning vehicle’s technical condition, the way it was driven and road transport safety (RTS). The recorder may be used in private and commercial cars, tåxis, buses and trucks. The recorder may serve the purpose of a neutral witness for the police, courts and insurance firms, for which it will facilitate making the reconstruction of the road accidents events and will provide a proof for those who caused them. The device will bring efficient driving, which will significantly contribute to decreasing the number of road accidents and limiting the environmental pollution. German Parliament in 2012, backed a proposal to the EC to put black boxes, which gather information from vehicles involved in accidents, in all the new cars from September 2015 on.

Zmniejszenie liczby wypadków drogowych przez monitorowanie zachowań kierowców

Streszczenie

Referat dotyczy problemów zmniejszenia liczby wypadków drogowych przez monitorowanie zachowań kierowców przy zastosowaniu pokładowego rejestratora zdarzeń (EDR) - czarnej skrzynki dla wszystkich typów pojazdów samochodowych. Urządzenie będzie rejestrować wiele danych nt. stanu technicznego pojazdu, sposobu jego prowadzenia oraz BRD. Rejestrator może być wykorzystany w samochodach osobowych, służbowych, taksówkach, autobusach, samochodach ciężarowych. Rejestrator może pełnić rolę neutralnego świadka dla policji, sądownictwa i firm ubezpieczeniowych, którym ułatwi rekonstrukcję przebiegu wypadków drogowych i dostarczyć dowodów na temat jego sprawców. Urządzenie przyczyni się do zgodnej z przepisami i ekonomicznej jazdy, co w znaczny sposób ograniczy liczbę wypadków drogowych oraz zanieczyszczenie środowiska. Niemiecki parlament w 2012 roku wystąpił z peticją do Komisji Europejskiej o wprowadzenie obowiązku wyposażania nowych samochodów, począwszy do września 2015 roku, w czarne skrzynki, które gromadzą dane o pojeździe biorącym udział w wypadku.
BIBLIOGRAPHY


6. ETSC’s Contribution to CARS 21 WP1 on Road Safety. February 2012.


22. Source for fatalities: CARE (European Road Accident Database); Source for demographics: EUROSTAT; Euro Geographics for the administrative boundaries; European Commission - DG MOVE – April 2014.