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Review Article

THE USE OF EVENT DATA RECORDER (EDR) – BLACK BOX

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ABSTRACT
The paper refers to the registration of road events by a modern device called EDR – black box for all types of the motor vehicles. The device records data concerning vehicle's technical condition, the way it was driven and RTS. The recorder may be used in private and commercial cars, taxies, 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. In the end in the last year German parliament backed a proposal to the European Commission to put black boxes, which gather information from vehicles involved in accidents, in all the new cars from 2015 on.

Keywords: Event Data Recorder, EDR – black box.

INTRODUCTION

The number of fatal road accidents' victims in European Union was reduced (Figure 1) from 54 000 in 2001 to nearly 31 000 in 2010 and 28 000 in 2012 [14]. 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) [19]. 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 2011 was 61, while in Poland – 109 (Table 1).

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, 9].

One of primary tasks of accident reconstruction is to determine the values of the event participants motion parameters prior to its occurrence.

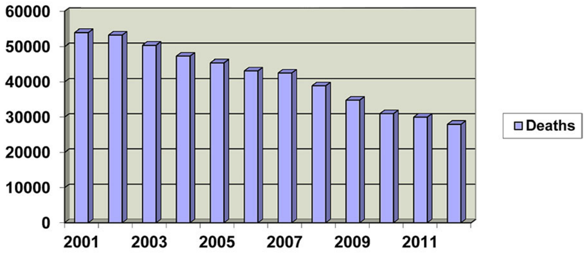

Fig. 1. Road fatalities in the EU since 2001 to 2011 [Based on CARE, EU road accidents database, 06.03.2013, http://ec.europa.eu/roadsafety]

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' (devices used for accident reconstruction) [5].

The goal is 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 [10]:
- create an instrument for support to make clear specific road traffic accident (chain accident, etc.),
- make easer the guilty and innocence clarification,
- make easer 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).

Table 1. Fatalities by population in Member State of EU from 2010 to 2012 [Based on CARE, EU road accidents database, 06.03.2013, http://ec.europa.eu/roadsafety and EC report from 19.03.2013, http://www.eurofundsnews.pl/content/view/20442]

No	Country	2010	2011	2012	The average from 2010 to 2012
1.	United Kingdom	31	31	28	30
3.	Sweden	28	33	31	31
2.	Nederland	32	33	32	32
4.	Denmark	46	40	32	38
5.	Malta	36	41	26	37
6.	Ireland	46	41	36	41
7.	Deutschland	46	49	32	42
8.	Spain	54	45	41	47
9.	Finland	51	54	48	51
11.	France	63	61	56	60
12.	Austria	66	62	64	61
10.	Slovak Republic	68	60	55	61
16.	Luxemburg	64	64	65	64
14.	Italy	68	64	62	65
15.	Slovenia	67	69	59	65
13.	Hungary	74	64	60	66
19.	Estonia	58	75	65	66
22.	Cyprus	73	85	59	72
17.	Czech Republic	76	74	71	74
18.	Portugal	79	74	71	75
20.	Belgium	77	78	73	76
21.	Latvia	97	86	86	90
23.	Bulgaria	103	89	82	91
24.	Lithuania	90	97	100	96
25.	Romania	111	94	96	100
26.	Greece	111	101	92	101
27.	Poland	102	109	93	101
	The average of EU	62	60	55	59

CHARACTERIZATION OF EDR

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 [6].

The recorder proposed by the Motor Transport Institute, to a large extent, may help reduce the number of accidents, a 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.

A significant disadvantage is the fact that currently there are few standards referring to such devices. SAE J1698 Standards Committee was established to develop common data output formats and definitions for those data elements that could be used for analyzing vehicle events, including accidents. The standard also specifies common connectors and network protocols to improve data extraction activities [21].

The IEEE P1616 Standards Committee was established to define a protocol for motor vehicle event data recorder output data capability and export protocols for data elements. The committee established these protocols for both light- and heavy-duty vehicles [11]. SAMOVAR project [16] was developed within DRIVE II program by, among others, participants:

- Queen Mary & Westfield College (QMW) drom UK,
- IMPETUS Consultants Ltd from Greece,
- ICS Black Box (UK) Ltd.,
- Man Technologie AG from Germany,
- The Motor Industry Research Association (MIRA) from UK,
- Transport & Road Research Labaratory (TRRL)from UK,
- SWOV Institute for Road Safety Research from Netherlands,
- Royal Mail (RM) from UK,
- IMRS University of Bremen from Germany,

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 (2005–2006) and Veornica II (2007-2009) [17].

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. Yhe 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 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 [18].

LEGISLATION REQUIREMENTS OF EDR

The US National Highway Traffic Safety Administration – NHTSA [12, 23] 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.

NTHSA 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 usingsafety belts) [24].

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 [21]. 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 15 722 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 [4] 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 [3], as a result of a collision, by 20%. For the reasons mentioned, the EC recommends eCall pan-European system for the EU [20].

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%.

Last year in November German parliament, the Bundestag 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 2015 on [25]. German ministry for traffic, the Verkehrsministerium, 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.

FUNCTIONAL REQUIREMENTS OF THE RECORDER

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 (Figure 2).

Event Data Recorder should be in line with all specifications (environmental, physical and electromagnetic compatibility) determined by EU directives and standards defined by CEN, ISO and ETSI. The main terms are the following:

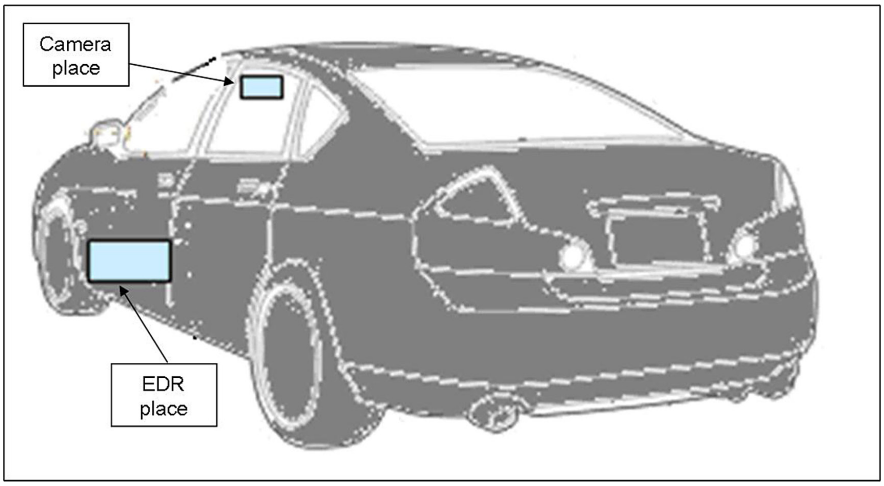

Fig. 2. Installation place of EDR and camera [Based on own study and work]

- Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits. (Official Journal L 077, 26/03/1973 P. 0029 – 0033). Electrical equipment means any equipment designed for use with a voltage rating of between 50 and 1 000 V for alternating current and between 75 and 1 500 V for direct current;
- Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility. (Official Journal L 139, 23/05/1989 P. 0019 – 0026);
- Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity. (OJ L 91, 7.4.1999, p. 10–28). Telecommunications terminal equipment means a product enabling communication or a relevant component thereof which is intended to be connected directly or indirectly by any means whatsoever to interfaces of public telecommunications networks (that is to say, telecommunications networks used wholly or partly for the provision of publicly available telecommunications services). Radio waves means electromagnetic waves of frequencies from 9 kHz to 3000 GHz, propagated in space without artificial guide;
- PN-ETS 300 135:1997/A1:1999. Radio Equipment and Systems. Angle-modulated Citizens' Band radio equipment. Technical characteristics and methods of measurement. This standard is based upon CEPT Recommendation T/R 20-02 (1972, with subsequent amendments): "Low-power radio transmitter-receivers intended to provide voice radio communications in the 27 MHz band (PR 27 Radio Equipment), and CEPT Recommendation T/R 20-07 (1982, with subsequent amendment): "Free circulation for use in different countries, of low-power mobile and portable transmitter-receivers in the 27 MHz band;
- PN-ETS 300 673:2005. Radio Equipment and Systems (RES). Electromagnetic Compatibility (EMC) standard for 4/6 GHz and 11/12/14 GHz Very Small Aperture Terminal (VSAT) equipment and 11/12/13/14 GHz Satellite News Gathering (SNG) Transportable Earth Station (TES) equipment;
- PN-ETSI EN 300 433-2 V1.1.1:2003. Electromagnetic compatibility and Radio spectrum Matters (ERM), Land Mobile Service, Double Side Band (DSB) and/or Single Side Band (SSB) amplitude modulated citizen's band radio equipment, Part 2: Harmonized EN covering essential requirements under article 3.2 of R&TTE Directive;
- PN-ETSI EN 301 489-1 V1.6.1:2006. Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements;
- PN-ETSI EN 301 489-13 V1.2.1:2003. Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 13: Specific conditions for

Citizens' Band (CB) radio and ancillary equipment (speech and non-speech);
- PN-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 P1616. Motor Vehicle Event Data Recorders Institute of Electronic and Electrical Engineers (IEEE), 2010. This standard specifies minimal performance characteristics for onboard tamper- and crash-proof memory devices for all types and classes of highway and roadway vehicles. This international protocol will help manufacturers develop what is commonly called "black boxes" for autos, trucks, buses, ambulances, fire trucks and other vehicles. It includes a data dictionary of 86 data elements and covers device survivability [7, 11];
- J1698 – J1698-1. Vehicle Event Data Recorder Interface – Vehicular Output Data Definition Society of Automotive Engineers, SAE, 2003. The scope of the SAE J1698 standards development effort is to develop common data output formats and definitions for a variety of data elements that may be used for analyzing vehicle "events," most notably crashes. The standards are intended to govern data element definitions and data extraction methodology as applicable for light-duty (less than 8500 lbs GVW) original equipment applications. Further, the standard will specify common connectors and network communications protocols to facilitate the extraction of such data [7, 22].
- SAE J1939-71 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 [15].

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.

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.

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 multiwire 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 on Board 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. The actual sensors in car were presented in Figure 3.

TECHNICAL REQUIREMENTS OF THE RECORDER

One element of accident reconstruction 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. The version 1 of device will be equipped with the following elements (Figure 4):

- Microprocessor module – the element controlling the operation of all other components.
- GPS – to receive the geographical coordinates.
- Module „black box" – memory chips, including SD card, capable of recording the driving and operating parameters.
- Digital inputs module – this module allows connection of digital signals.
- Analogue inputs Module – this module allows connection of analogue sensors.
- CAN inputs module – to connect CAN bus in the FMS standard.

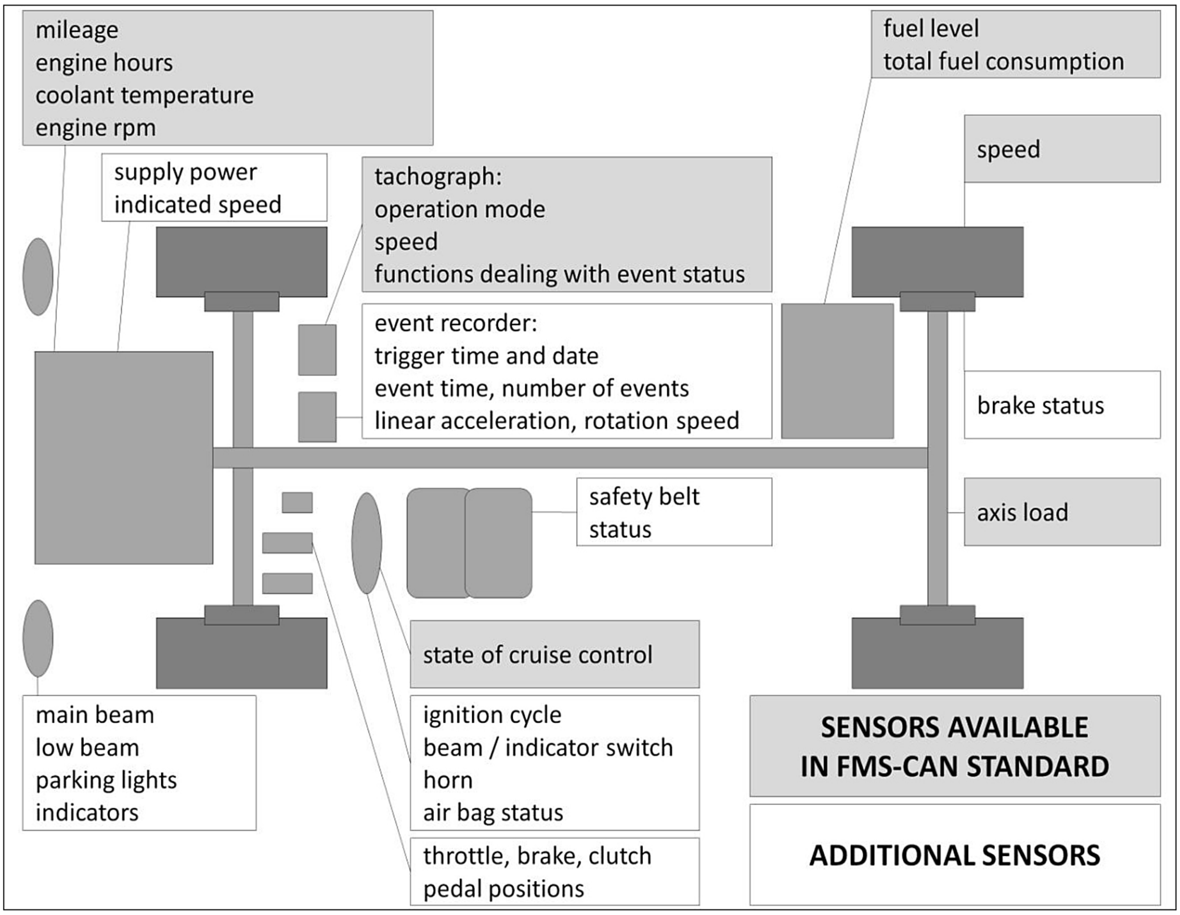

Fig. 3. Monitoring sensors in vehicle [8]

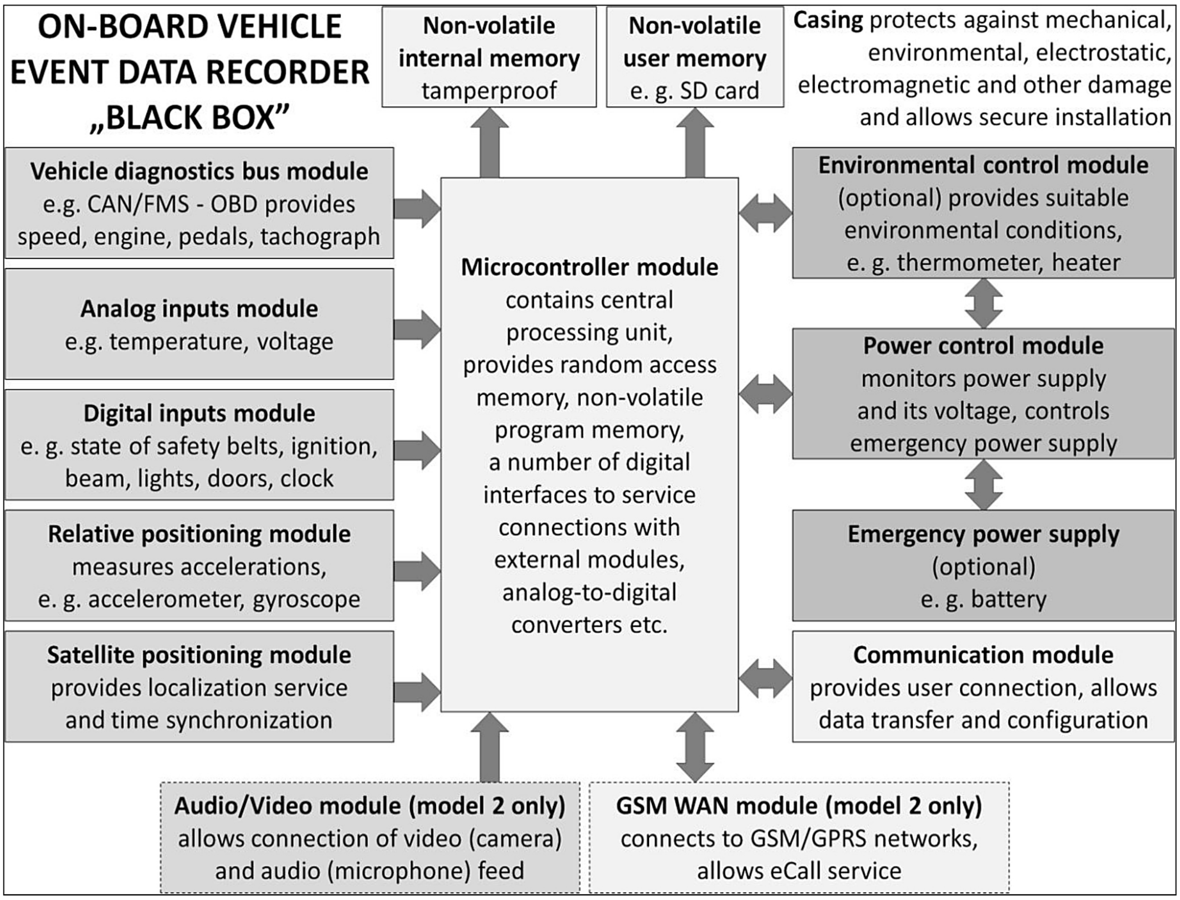

Fig. 4. On-board vehicle, event data recorder functional structure [G. Nowacki, A. Niedzicka]

- Battery backup module.
- Housing.

Devices will be connected to the CAN bus and to the selected electrical circuits of the car. The design may not allow for manipulation or external sensors, such as their exclusion. It will be deprived of the possibility of changing the stored data, connected directly to the accident.

The device must be designed so as to minimize the reconstruction error of the motion parameters, in particular trajectory of the movement. This error should be the smallest degree dependent on the vehicle load.

The unit will have an airtight case ensuring resistance to a short-term immersion in water and service liquids (fuel, oil, hydraulic fluid). It will withstand exposure to direct flame and high overload for a period of several milliseconds.

Equipment should be protected against shock and vibrations in accordance with the standard defined in the EN normative documents (environmental conditions, electromagnetic compatibility). All mobile devices should withstand the following exposure: a one-time shock and falls from a height of 1 m. The devices should be able to withstand vibration, both sinusoidal and random.

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

The end result of the conception will be turning out two devices: 1 – the economic, universal simple event data recorder 'black box', 2 – 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. In order not to violate privacy, car black boxes will store the data recorded for 30 seconds before the accident and 15 seconds after it. 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.

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REFERENCES

1. Bach, H., The use of drive data recorders and accident data recorders and their socio-economic evaluation, Technische Universität Dresden, 2000. www.roadpeace.org
2. Commission Recommendation of 8 September 2011 on support for an EU-wide eCall service in electronic communication networks for the transmission of in-vehicle emergency calls based on 112 ('eCalls'). 2011/750/EU) L 303/46, Brussels, 2011.
3. Cost-benefit assessment and prioritization of vehicle safety technologies in particular 142 seq. (144) and p. 8). European Commission Directorate Energy and Transport. ww.ec.europa.eu/transport/roadsafety_library/publications/vehicle_safety_technologies_final_report.pdf.
4. European Parliament resolution of 27 September 2011 on European road safety 2011-2020. P7_TA-PROV(2011)0408. Brussels, 2011.
5. Guzek M., Car 'black boxes' in road accident reconstruction analysis. Transport No 82, Warsaw, 2012.
6. Kowalick T.M., Protects the security, integrity and authenticity of vehicle crash data. Georgetown University Law Center 600 New Jersey Ave NW, Washington, D.C. 2011.
7. Kowalick T.M., Motor vehicle EDR' global standardization and related issues. National Research Council / National Academies. Keck Center, 500 Fifth St., NW, Washington, D.C. 2010.
8. Merkisz J., Inteligentne rozwiązania systemów informacyjnych w pojazdach osobowych i ciężarowych (Intelligent solutions of information systems in HGV and cars). No 602 Transport and Logistics Problems, 12, 2010, 169-172.
9. Merkisz J., Tarkowski S., Selected aspects of using deck recorders in automotive vehicles. Reliability and Maintenance, 2, 2011.
10. Messerschmidt W., Smith B., Messerschmidt K., Minimizing the Risk of Losing Valuable Forensic Data When Downloading the Electronic Control Modules (ECMs) of Heavy Commercial Vehicles Technical White Paper. Messerschmidt Safety Consultants Birmingham, 2011.
11. Motor Vehicle Event Data Recorders. Institute of Electronic and Electrical Engineers (IEEE), IEEE P1616 Standards Committee, February, 2005. http://www.fmcsa.dot.gov/facts-research/research-technology/report/vehicle-data-recorders-dec05/chap1.htm
12. NHTSA 49 CFR Part 563 Issued 2006, amended 2008. Effective Sept. 2012 New NHTSA EDR Part 563 rule for Sept 2012 standardizes EDR minimum data set, insures public access to data, and that data survives in severe crashes. http://www.nhtsa.gov/EDR.

13. Plíhal J., Pípa M., Black box - project V&V. National Highway Traffic Safety Administration. MD ČR, Praha 2010.
14. Report on accidents, Care & national data. European Commission, Brussels 2012.
15. SAE J1939-71 Standard. Revised: 2013-09-03. Vehicle Application Layer, http://standards.sae.org/j1939/71_201309.
16. SAMOVAR - Safety Assessment Monitoring On-Vehicle with Automatic Recording Project. 1995, https://gforge.inria.fr/projects/samovar.
17. Schmidt-Cotta, R. R., Vehicle Event Recording based on Intelligent Crash Assessment. Final Report, VERONICA II. 06.10.2009.
18. Spek, A., Bot, H., Accuracy of freeze frame data and EDR data in full scale crash tests. International Conference, European Associiation for Accidnt Research and Analisis, 2012, http://www.evuonline.org/en/component/content/article/1066.
19. Symon, E., Prophylactic and Analyze Group of BRD. KGP, Warsaw 2012.
20. The EU eCall: Time for Deployment, Brussels, 21.8.2009, COM (2009) 434 final; http://ec.europa.eu/information_society/activities/esafety/ecall/index_en.htm.
21. Towards to the European Road Safety Area: Policy orientations on road safety 2011-2020. EC 2010.
22. Vehicle Event Data Interface – Vehicular Output Data Definition Society of Automotive Engineers (SAE). J1698 Standards Committee – J1698-1 Standard, SAE, December, 2003.
23. Westbrook, R., Evaluation of electronic data recorders for incident investigation, driver performance, and vehicle maintenance project Bd549-50. Final report. University of South Florida, September, 2009.
24. Working Paper. Event Data Recorders (EDR) on Vehicles. Privacy and data protection issues for governments and manufacturers. EDR: Definitions and facts. 49th Meeting, Montreal (Canada) 4-5 April 2011.
25. ZDNet article. Germany's cars to get teched-up as parliament proposes black boxes for vehicles by Jung, J. 2012. http://www.zdnet.com/germanys-cars-to-get-teched-up-as-parliament-proposes-black-boxes-for-vehicles-7000003488.