EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

Vehicle Event Recording based on Intelligent Crash Assessment

VERONICA – II

(EC Contract No. TREN-07-ST-S07.70764)

Final Report

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Caveat

The information contained in this Project Veronica-II Final Report has been collated following wide-ranging consultation with practitioners that includes collision investigators, enforcement authorities, legal institutions, public and private sector representatives and relevant EU and EU Member State governmental organisations. Accordingly this Report provides evidence and guidance on Project Veronica-II's emerging findings; to support this, the Report also draws upon an exhaustive examination of the US standard on EDRs. Where they are available the known evidence, drawn from a diverse range of public and private sector organisations, has been incorporated within this Report to present a definitive statement on recommendations for EDR requirements in Europe at mid-2009.

The Project Final Report aims to present EDR's most appropriate requirements, also to collate and consolidate information that will aid the introduction of EDR technologies in Europe and to provide a recommendation for a draft Directive. This includes requirements essential to the most effective evidential chain that will ultimately satisfy road safety research, collision investigation requirements and procedures.

This Project Final Report incorporates the emerging findings from Project Veronica-II's research to date, and although incomplete, represents an authoritative comment on the current state of EDR technologies; consequently this Report is commended, in lieu of contradictory information, as current 'best evidence'

List of Content

1.1 Purpose of EDRs

Reducing the number of fatalities

Because actions to reduce the number of road fatalities by 2010 are falling behind the goals more in-depth data is required to enhance the information available for research purposes with the aim of improving road safety in terms of road infrastructure, vehicle design and training. There is also a need to learn more about the relation between crash severity and vehicle damages on one side and injury severity and impact direction on the other. In addition individual accident reconstruction will profit from the analysis of EDR data.

However, behavioural and preventive benefits are not to be disregarded. The benefits can outweigh the costs by a factor 7. Detailed information on this can be found e.a. in the study on "Cost-benefit assessment and prioritisation of vehicle safety technologies" conducted by an international research team for the European Commission in 2005. Deliverables of the PRAISE Project initiated by DG Tren in June 2009 will come up with examples on safety benefits in an occupational road safety environment (e.g. drivers operating under fleet, working shift or insurance conditions for which Veronica-I had already provided average benefits of 25%).

In-depth research

In-depth road safety research as promoted for example. by ERSO, but without real-life data provided by EDRs, will not fulfil its expectations. It is recommended that for enhanced in-depth research purposes EDR data should play a more prominent role in future EC actions.

Vulnerable road users

The statistics reveal the relevance of accidents with vulnerable road users which represent between 20% and 25% of all road fatalities. Vulnerable road users should therefore become a focus of road safety research.

‘Soft object’ collisions

Technically speaking accidents with vulnerable road users involved are soft object’ collisions. If EDR data is to be used to comprehensively enhance road safety the event definition must also comprise the detection of these ‘soft object’ collisions, i.e. collisions with vulnerable road users. As their share among road victims is considerable it cannot be neglected.

In order to make EDRs record such collisions a trigger specification is required which goes further than the air-bag related NHTSA specifications as these only focus on the protection of the vehicle occupants rather than any road users outside the vehicle or non-vehicular property.

Personal injury accidents

The number and ratio of personal injury accidents involving vehicle occupants and other (soft object) road users has declined much less than those of fatalities. This implies an ongoing need for in-depth research.

Property damage accidents

The statement before is applicable also to the property damage accidents**.** Numerically property damage accidents are far more frequent (up to more than 7 times greater) than those involving personal injuries.

Total property damage costs are equal to the socio-economic costs of personal injuries (Germany).

Event definition (‘Wanted’ events)

Taking into account what has been said to the type and relevance of accidents, the event understanding for European EDRs comprises, as a minimum, the ’wanted’ accidents – i.e. those accidents which result in harmful serious consequences; which are described as:

- all fatalities among drivers, occupants and other road users, in particular pedestrians and two-wheeler riders and drivers
- all serious injuries to drivers, occupants and other road users, in particular pedestrians and two-wheeler riders and drivers
- all damages which make host and other vehicles unusable and serious damage to non-vehicular property.

Research data bases

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

Data networks

Consideration may be given for the data networks to be used by private bodies (e.g. research data bases), provided they have a public appointment, to do so, and it is a recommendation that the data network has a legal status that provides the enforcing authority.

1.2 Technical requirements

The technical requirements are a function of the politically intended purposes of EDR implementation in Europe as they have been outlined above. Because of this EDR functionallities in Europe have to some extent be more demanding than the US NHTSA requirements.

Minimum storage capacity

A minimum storage capacity for 3 ‘wanted’ accident-events is required. One accident-event may consist of several impacts a vehicle may cause or suffered.

Safety and diagnostic purposes

Data requirements recommended by Project Veronica do not restrict manufacturers recording other data without harmful consequences, e.g. for safety and diagnostic purposes.

Intelligent ‘trigger’

The ‘triggering’ of the recording process of all wanted accidents finds its constraints in physical conditions (vulnerable road users are 'soft objects'), in storage capacity and data privacy concerns. Therefore an air-bag linked ‘trigger’ is not sufficient and a more intelligent ‘trigger’ has to be considered, what we call a corrected ‘trigger’. This ‘trigger’ reduces the braking impact on the ‘triggering’-relevant deceleration curve which originally comprises the deceleration values ‘braking plus crash impact’.

Design neutrality

‘Triggering’ is not design restrictive and is independent from the definition of the

event scope. By prioritising triggers from deployable devices it should be possible to keep unwished ‘triggers’ to a minimum.

NHTSA Standard on Data Elements

To a considerable degree VERONICA follows the choice of data elements taken by NHTSA.

VERONICA Standard on Data Elements

The requirements referring to frequency/range, accuracy, resolution and crash phases are fulfilled by the NHTSA standard only to a very low degree whereas the VERONICA values cover the requirements imposed by the use of EDR data to a far higher degree.

SAE standard on Signals

A large number of the signals to be fed into EDR are already standardised by the SAE J1939-71 standard. The other required signals will be standardised by a first change request. There is also the need to standardise the common interface.

Download Interface

The OBD connector could provide EDR download functionality as long as the communication protocol etc is correctly defined.

eCall

- There are congruencies between EDR and eCall:
- The algorithm which initiates an eCall can also be used for the recording of hard event collisions and vice versa.
- eCall modules, according to an informal comment received from one OEM, provide a large amount of information. An EDR might be realised by means of a software extension.
- EDR should also record when an eCall was transmitted. It is difficult to decide, whether the last position data are valid or not, because the GPS signal might have been masked whilst passing through or by a tunnel, high buildings etc.
- In a future step a link from EDR to eCall could ensure that information on crash severity is automatically transmitted to the PSAPs and rescue centres.
- It is also considered important that false ‘112' alarm activations were prevented.

1.3 Data Security and Data Privacy

Data Security

A number of principles and realistic goals for data security should accompany the implementation of EDR:

- Simple and open gains
- Given sufficient motivation, someone will try to ‘hack’ into any system.
- Be at least as secure as the system previously installed and aim to be better

- Do not introduce complexity unless forced to do so
- Especially, don’t introduce complexity for some esoteric reason or scenario

Data privacy

The project team has unanimously agreed that no personal driver data shall be registered by the EDR. It has also to be underlined that there is no continous recording of drivers' behaviour nor a position monitoring. EDR data are recorded only in cases of an accident and then only for less than a minute. The use of EDR recorded accident data has to follow the same rules of trustworthiness and confidentiality as they are applied to accident data collected with the tools presently available to accident reconstructionists. To assure the project team about this there was a workshop on data privacy held with the 'European Academy for Freedom of Information and Data Protection' (EAID) as it had been the case already in the VERONICA-I project.

Inherent security measures

As access to EDR data requires access to the vehicle itself EDRs do not need a highly sophisticated security infrastructure to protect their data for confidentiality, integrity, availability and authenticity as existing security measures provide sufficient means to inhibit most attacks.

Trusted download

It is essential to ensure that the data is secured as it is removed from the vehicle therefore it is suggested that event data downloaded from an EDR is digitally signed by the authorised expert or organisation that is engaged in the download. This will confirm that the download was performed correctly at a certain date and time, from the correct vehicle and device, and verified with a digital seal that records the transaction. Any later changes to the record will be readily detected.

1.4 Legislation

The project partners studied the existing EU legislation related in one way or another to the issue of this project. Into their focus came in particular

- Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers, having been repealed by Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007, establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles;
- Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data;
- Council Decision 97/836/EC, the Community acceded to the Agreement of the United Nations Economic Commission for Europe concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted to and/or used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions (Revised 1958 Agreement);

- Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and 6) and on access to vehicle repair and maintenance information
- Proposal for a Directive of the European Parliament and of the Council concerning type-approval requirements for the general safety of motor vehicles (COM/2008/0316 final - COD 2008/0100)

Having studied the existing legislation the Veronica II partners considered appropriate to propose to DG TREN a number of legal and technical measures on the installation and use of Event Data Recorders for certain categories of motor vehicles in the Community.

2 Partners and Work Programme

2.1 Partners

Continental Automotive GmbH (Project Management)

ACTIA Automotive SA

CEA – Insurers of Europe (associated)

CORTE – Confederation of Organisations in Road Transport Enforcement

Ford Werke GmbH

Granturco & Partners Avocats - Lawyers

Kast GmbH Accident Research

Stoneridge Electronics AB (supported by ATSEC information security GmbH)

2.2 Work Programme

2.2.1 WP 2: Rule Making for data administration

D 2-02: Event Definition

Agreement on what is an event; how many events shall be stored, how long, definition of 'trigger' scenarios (vehicle modus, vehicle category)

D 2-03: Data privacy issues

Binding agreement on minimum data protection and security requirements (access control) inside the vehicle and outside for requirements of accident investigation, accident research (European accident data bank) and legal purposes, chart of information flow

D 2-04: Data use outside the vehicle

Functional requirements for accident investigation: Binding agreement on user rights, qualification, administrative structures and procedures for data use in accident research with data banks (content, access control, person related data) and legal purposes (Centralised or decentralised data administration)

2.2.2 WP 3: Rule making for European EDR Technology

D 3-02: Definition of information requirements and data quality for relevant vehicle categories on basis of VERONICA I

Consensus on information requirements depending on vehicle categories, based on impact, noise, distance and/or visual crash

	detection. The output will be also a table which divides the information requirements into the three relevant phases (pre-crash, crash and post-crash) per vehicle category. Binding agreement on information requirements, e.a. acceleration, yaw rate and the minimum performance (Measuring and frequency ranges, sensitivity) Binding agreement on sampling rate, recording frequency and data structure
D 3-03	Converted into Sub-Deliverable as part of D 3-02
D 3-04:	Definition of common physical properties and protocol of the input interfaces as an efficient industrial standard, binding agreement on Input Interfaces
D 3-05:	Definition of necessary actions to safeguard data integrity and access controls (key length and procedures, requirements for legitimate access) Definition of "Security Targets"
D 3-06:	Definition of physical properties and definition of the protocol of the Download Interface unitary for all vehicle categories, binding agreement on the Download Interface
D 3-07:	Definition of power supply requirements and data survivability Agreement on binding standard for power supply requirements to gain and store the relevant data of each phase of the crash as well as the mechanical and electrical data protection.
D 3-08	Type Approval A new deliverable recognised as necessary.

2.2.3 WP 4: Drafting of the legal and technical deliverables

D 4-02:	Draft of regulation and/or directive and other appropriate legislative files
D 4-03:	Technical Annex Binding standard for technical requirements
D 4-04:	Explanatory legislative remarks Presentation of considerations which lead to the agreements and standards.

3 Meetings

3.1 Project Meetings

WP 1

21/22-5-07, Project Kick-Off, Siemens, Brussels

22-04-08, Update, DG Tren Road Safety Unit Brussels

30-05-08, Update, DG Tren Road Safety Unit Brussels

16-07-08, Update, DG Tren Road Safety Unit Brussels

10-10-08, Project Meeting, Villingen-Schwenningen

01-04-09, Meeting with DG Tren Member of VP Cabinet J.F. Colsman

01-04-09, Update, DG Tren Road Safety Unit Brussels

WP 2

27-06-07, Ford GmbH, Köln

20-07-07, Siemens VDO, Frankfurt

07-09-07, Telco

14-09-07, Telco

16-10-07, DG Tren, Brussels

22-11-07, Ford GmbH, Köln

21-04-08, bast, Bergisch-Gladbach

02-09-08 PM-CORTE-Board Meeting, Brussels

WP 3

18-09-07, Kick-off, Siemens, Brussels

22-10-07, Telco

11-12-07, ITR, Brussels

15-01-08, Kast GmbH, Heidenheim

19-02-08, Kast GmbH, Heidenheim

25/26-02-08, Atsec, München

12-03-08, Atsec, München

05-05-08, Atsec, München

03-07-08, Telco ATSEC, PM, G&P

WP 4

29-05-08, Kick-off, Granturco & Partners, Brussels

26-09-08, Joint WP Data Privacy Workshop, EAID, Berlin

3.2 Steering Committee Meetings

03-05-07, DG Tren, Brussels

17-10-07, DG Tren, Brussels

3.3 External Meetings

10-12-07, Dutch DoT, Utrecht

17/18-04-08, E-safety-ERSO, Rome

22-04-08, UNECE GRSG WP 29, Geneva

18-06-08, MEP M. Ferber, TC EP, Strasbourg

24/25-06-08, E-Call CEN TC278 WG15, Brussels

16-07-08, MEP D.-L. Koch, TC EP, Brussels

11/12-09-08, Erlanger Symposium, Digitale Daten in Geräten und Systemen

4 Figures and Tables

5 Project-Workflow

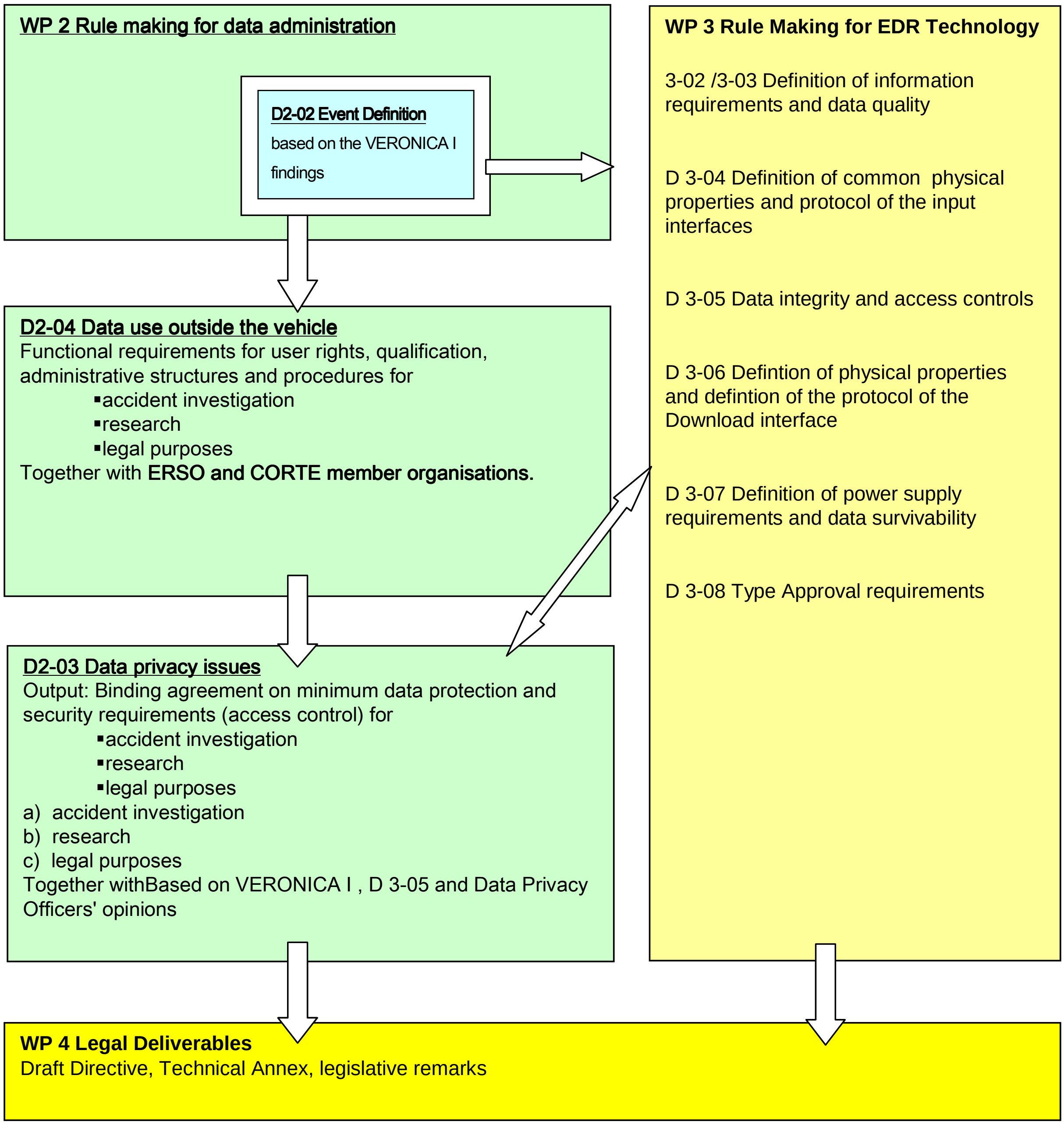

Fig. 1: Project Workflow

6 Presentation of results

6.1 Rule Making for data administration

6.1.1 Event definition

6.1.1.1 Explanation and discussion of the Event Definition

Veronica I had agreed on the following Event Definition:

⇨ ***" 'Accident' means 'an unwanted or unintended sudden event or a specific chain of such events which have harmful consequences'."***

The reasoning behind it is the following:

A distinction between possibly risky driving events and those which lead to accidents, (i.e. events with harmful consequences) was necessary in order to avoid data privacy problems.

⇨ **At various occasions, data privacy experts made it clear that any sort of Journey Data Recording would not be acceptable because of excessive collection of personal data.**[3]

As a matter of comparison the TRL event definition was quoted:

"A rare, random, multi factored event where one or more road user loses control of his/her environment"

The project members agree that this definition is too wide and does not correlate with accidents where only damage is caused; thereby this definition fails to conform to the rationale to enhance road safety provisions.

⇨ **It is also confirmed that data requirements recommended by Veronica-I do not restrict manufacturers recording other data without harmful consequences, e.g. for safety and diagnostic purposes.**

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[3] References:

1) Data Privacy Workshop 27-03-2006, Berlin, Minutes, DWS, Veronica-I, WP 4;
2) Regeln und Grenzen für Erfassung, Speicherung und Verwertung von Daten in Verkehr; Peter Schaar, Bundesbeauftragter für den Datenschutz und die Informationsfreiheit, Datenschutzbehörde des Bundes, Berlin, ADAC-Fachgespräch 28-09-2006, http://www.adac.de/Verkehr/Verkehrsexperten/glaeserner_autofahrer/default.asp?ComponentID=166170&SourcePageID=32796;
3) Meeting of the Article 29 WP on 07-11-2006 in Brussels; no minutes were disseminated to guests; but informal notes were received from Simon Labbett (ACPO) and Thierry Granturco (CORTE) who were invited to present for the Veronica-I Team.

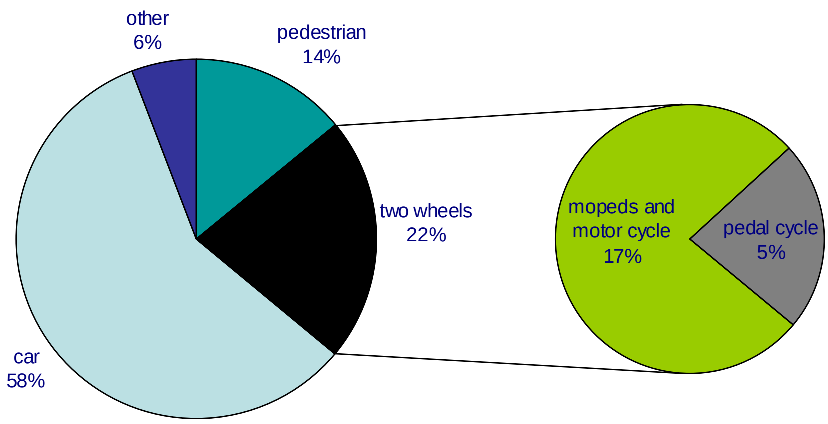
6.1.1.2 Statistical Material / Comprehension of 'harmful consequences'

For better comprehension of what 'harmful consequences' mean, the following statistics were introduced into the study:

- Fatalities according to road user categories (2 charts: EU 15 and Germany),
- Relationship between people killed and injured (Germany)
- Relationship between personal injuries and property damage (Germany)
- Ratio between accidents with personal injuries and all accidents (three countries)

Statistical material

2004 – EU 15 fatalities all ages



Source: CARE and national data according to "Commission Staff Working Document, European Road Safety Action Programme – Mid Term Review, SEC (2006) 221"

Fig. 2: EU Fatalities

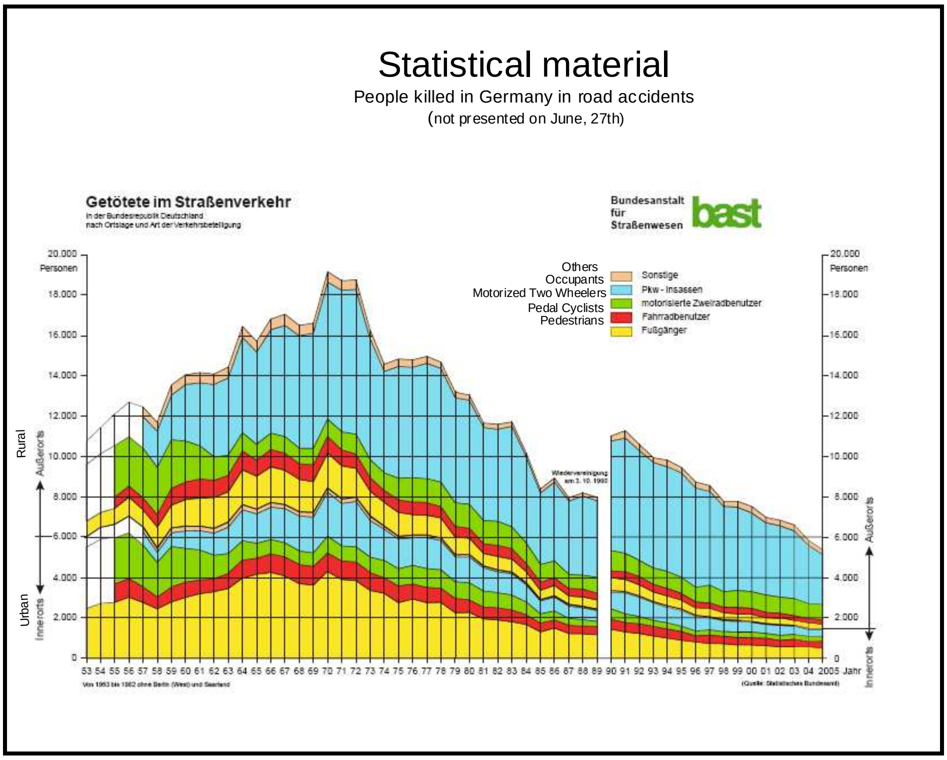


Fig. 3: Fatalities in Germany by road users

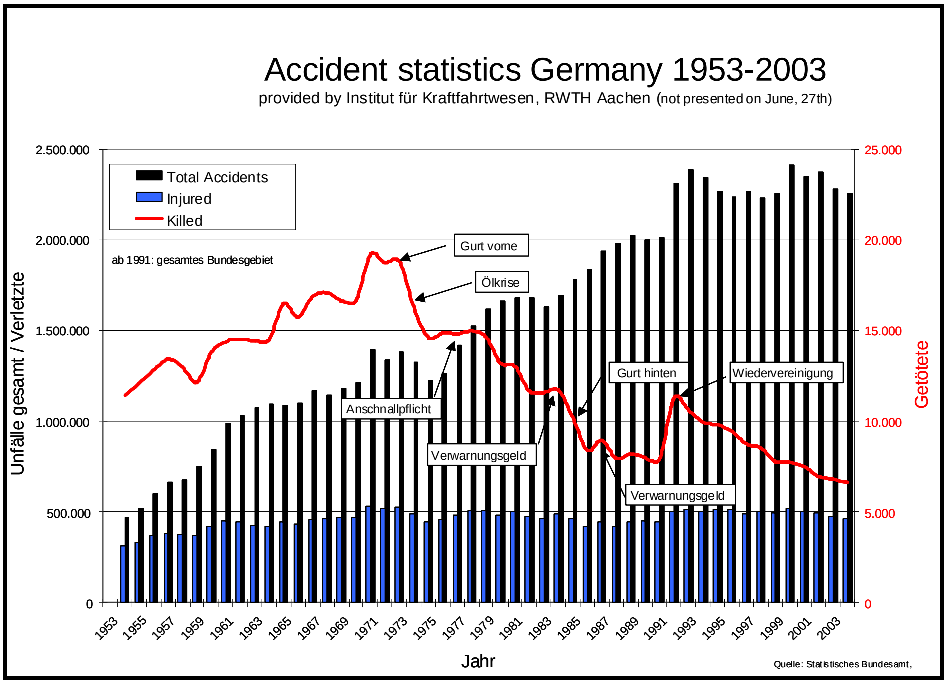


Fig. 4: Accidents in Germany by consequences

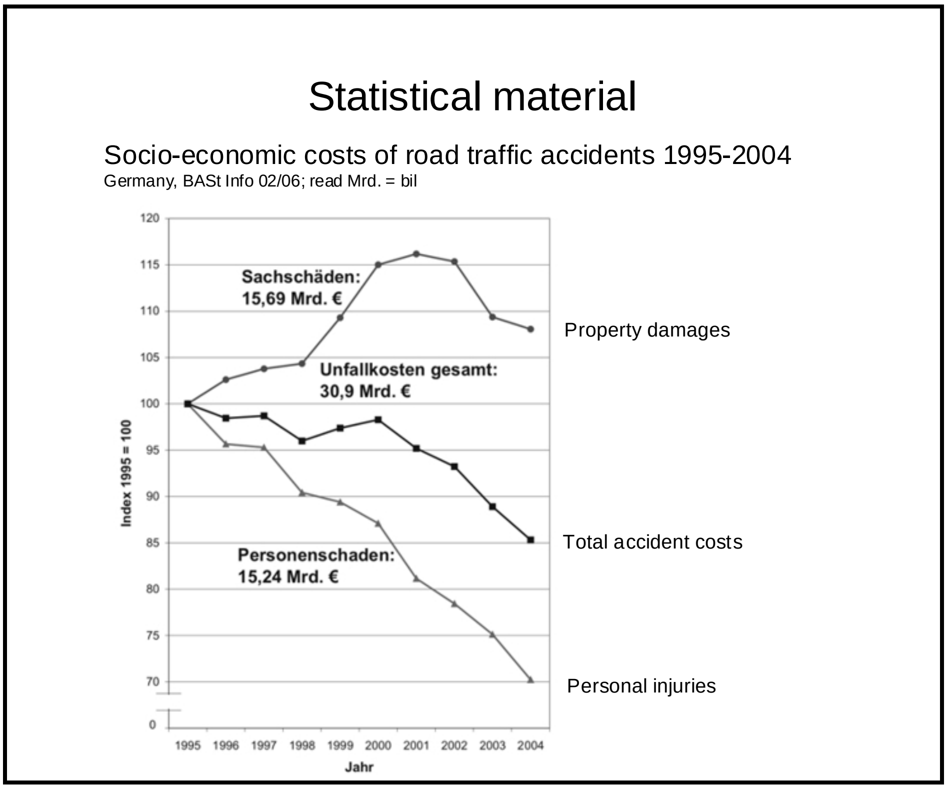


Fig. 5: Accidents in Germany by type and amount of costs

Statistical material

Ratio number of accidents with personal injuries **:** total number of registered accidents

Germany, Netherlands, Denmark, 2006. DG Tren, Maria-Teresa Sanz-Villegas, June 25, 2007 (not presented on June, 27th)

Country	**No. of accidents with personal injuries**	**Total No. of accidents**	**Ratio (ca.)**
D	300.000	2.000.000	1:7
DK	5.600	15.000	1:3
NL	25.000	122.000	1:5

Remarks: Degree of accident registration by police varies from country to country considerably. No harmonized figures are available. A general trend indicates that police increasingly withdraws from registration of accidents with only property damages. This applies also to the case of Germany.

Fig. 6: Accidents in D/DK/NL by ratio of accidents with injuries

⇨ **The statistics reveal the relevance of accidents with vulnerable road users which represent between 20% and 25% of all road fatalities and those where only property is damaged:**

- Numerically property damage accidents are far more frequent (up to more than 7 times greater) than those involving personal injuries.
- **Total property damage costs are equal to the socio-economic costs of personal injuries (Germany).**
- **The number and ratio of personal injury accidents has declined much less than those of fatalities.**
- It was noted that in some countries accidents for some sectors are currently experiencing rising numbers relating to personal injury accidents.
- According to statistics available from ika (Source: German Federal Agency for Statistics, destatis) in six of sixteen German Länder the number of fatal accidents had recently risen whilst the overall number of personal damage accidents was declining as statistics for 1-10/06 show – not inserted into presentation.
- The German Federal Agency for Statistics states there has been a 10% increase in fatalities among drivers of commercial vehicles for 2006 compared to 2005 (DVZ, July 26th, 2007).
- The Neue Zürcher Zeitung, on July 4th, 2007, quotes from the Swiss Agency for Statistics (BfS) Reports that the risk of being killed in an accident is 18 times greater for a motorcyclist than for car drivers or occupants, 7 times greater for pedal cyclists and 6 times greater for pedestrians
- The EC places a high priority on the problem of pedestrians and other vulnerable road users; see Directives 2003/102/EC and 2005/66/EC and the proposal COM(2007)0560 from 3/10/2007 for a regulation in this field.
- Statistics for the number and/or degree of injured or for property damages are not available for the European level.[4]

6.1.1.3 Physical restrictions to recording

It is commonly accepted that owing to unspecified physical restrictions it will not be possible to record 100% of all accidents.

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[4] References:

http://ec.europa.eu/transport/roadsafety/road_safety_observatory/annual_statistics_en.htm.
http://ec.europa.eu/transport/roadsafety/road_safety_observatory/rsap_midterm_en.htm
http://www.europarl.europa.eu/meetdocs/2004_2009/documents/pr/695/695864/695864en.pdf

⇨ **It has been decided therefore to make distinctions according to the degree of necessity in recording accidents in association with their consequence categories:**

- **Fatalities**
- **Injuries**
- **Property Damage**

‘Fatalities’ are to be understood as death or likely death within 30 days. 'Injuries' are to be understood as personal injuries; 'damage' means material damage to own and/or third party property. Further distinctions and rankings for the various sub-categories and difficulties of accurate recording were commonly determined as shown in the following table. 'Other' comprises in particular pedestrians and two-wheelers.

Results

Harmfull consequences

			degree of necessity
Fatalities	drivers		wanted
	occupants		wanted
	other		wanted
Injuries	drivers	serious	wanted
		minor*	nice to have
	occupants	serious	wanted
		minor*	nice to have
	other	serious	wanted
		minor	nice to have
Damage	host	unusable	wanted
		driveable (not roadworthy)	nice to have
		cosmetic	not required
	other vehicle(s)	unusable	wanted
		driveable (not roadworthy)	nice to have
		cosmetic	not required
	non vehicular property	serious	wanted
		minor	not required

wanted
nice to have
not required

*) without whiplash

Fig. 7: Harmful consequences by categories and necessity of recording

⇨ **The event understanding for European EDRs comprises as minimum the ‘wanted’ marked types of accidents, which result in harmful serious consequences, as there are:**

- all fatalities among drivers, occupants and other road users, in particular pedestrian and two-wheelers
- all serious injuries to drivers, occupants and other road users, in particular pedestrian and two-wheelers

- all damages which make the host and other vehicles unusable and include serious damage to non-vehicular property.

Due to physical reasons and in accordance with the final ‘trigger’ definition this requirement may result in the storage of not strictly relevant (i.e. ‘not-wanted’) events. Therefore in determining the number of events which have to be stored a distinction has to be made between ’registered’ events and ‘wanted’ or ‘necessary’ events. This has to be taken into account when defining the required minimum number of memory areas.

From the point of view of a consistent reconstruction of all types of accidents this minimum number should secure the storage of the last three ‘wanted’ events. This also takes into account regularly occurring post-accident manoeuvres like vehicle recovery and transport or even journey continuation. For fleet management purposes the ‘wanted’ event number may need to be higher.

It is noted that the vehicle industry favours a solution with storage for the last ‘wanted’ event only. Though it is agreed that the EDR has to ensure that the ‘wanted’ events are recorded and accessible the question remains to be explicitly answered regarding how many events are necessary.

From the point of view of accident reconstruction this can be answered by stating that there is broad and sufficient experience and evidence to suggest that three ‘wanted’ events are not unreasonable. However it can be left with the systems developers to decide how many ‘not-wanted’ events are necessary in order to secure the essential three ‘wanted’ events. Operational accident reconstruction expertise confirms that there are numerous common accident situations which demand that three ‘wanted’ events must be stored.

It is equally important that multiple requirements from the data clients like police, research, insurance, manufacturers are satisfactorily secured. This is different from North America where rule-making was based on voluntary implementation by the manufacturers.

⇨ **A minimum storage capacity for 3 ‘wanted’ events is required.**

Finally a terminological clarification is made to distinguish the meaning of ‘event’ from the meaning of ‘impact’:

⇨ **One accident-event may consist of several impacts that a vehicle may cause or suffer.**

This is a question of sampling rates and exactitude of the resolution of the sampled acceleration values and is important for the quality of the collision expertise; but it does not influence the event definition.

6.1.1.4 Relevance of Event Definition for ‘triggering’ the recording process

6.1.1.4.1 Meaning of 'Triggering'

'Triggering' means to start the recording (freezing) of data continuously generated, once a certain level of event severity (i.e. the ‘trigger’ threshold) is reached. If the ‘trigger’ threshold is not reached data are continuously overwritten by new data; in other words, they are neither stored nor recorded.

6.1.1.4.2 Discussion of the NHTSA/IEEE P1616 trigger threshold standard

(Event Data Recorders, Final Rule, 14-01-2008, F.R./Vol.73, p. 2181)

There are differing perspectives on EDRs in North America which concentrates on the hard impact and occupant oriented vision and Europe’s comprehensive road safety oriented vision. The latter considers collisions with vulnerable road users require a ‘trigger’ threshold that is defined as a change in vehicle velocity that equals or exceeds 8 km/h within a 150 ms interval. This is regarded as inappropriate by Veronica I and II for several reasons:

- This simple Δv event definition is not sufficient to record all relevant accidents e.g. cars with two-wheelers or with pedestrians (vulnerable road users) or Heavy Goods Vehicles (HGVs) with cars. Research by American EDR experts reveal that present ‘trigger’ technology leaves many low Δv events without airbag deployment, i.e. unrecorded and others with high uncertainties.[5]
- A more sensitive Δv event definition would not be intelligent enough to distinguish between e.g. full braking and a crash impact
- See also chapters 4.6.3 (Accident definition) and 4.12 (Degree of performance of requirement specification) in the Veronica-I Final Report

6.1.1.4.3 ‘Trigger’ requirements in the light of the Veronica-II mission

Intelligent combinations of several but not necessarily complicated ‘trigger’ parameters are necessary - e.g. combination with a standstill ‘trigger’. After studying almost 3.000 real life ADR[6] accidents experiences it can be concluded that 93% of all accidents come to a standstill within 3 seconds following the first impact.

As far as technical feasibility is concerned it has to be considered that ‘triggering’ could not only rely on Δv but also on deployable devices (pop-up bonnets, external airbags), by camera and radar parameters or by other technical input sources.

⇨ **‘Triggering’ is not design restrictive and is independent from the definition of the event scope.**

[5] Clay Gabler/John Hinch, SAE EDR Symposium,, Sept. 05/06, 2007, Ashburn, VA, USA and Craig Wilkinson, SAE EDR Symposium, Sept. 05/06,2007, Ashburn, VA, USA

[6] ADR= Accident Data Recorder, term often used in Europe for EDR

⇨ **The following 'triggers' are mentioned as relevant examples and are considered for the 'Trigger Scenarios':**

1. Airbag deployment
2. Other deployable devices
3. $\Delta v >= 8 km/h$ within 150 ms
4. $\Delta v >= 6 km/h$ within 120 ms
5. $\Delta v >= 4 km/h$ within 120 ms [7]
6. $\Delta v >= 2 km/h$ within 120 ms [8]
7. corr. dv >= 2 km/h within 120 m/s [9]
8. Standstill
9. Pedestrian detection
10. V2V /P2V com. [10]
11. Noise
12. Forward sensing
13. ABS
14. ESC
15. Manual (e.g. E-Call)
16. Others

6.1.1.4.4 Triggering by category of harmfulness and trigger scenario

The following table shows the degree of necessity of accident-event 'triggering' by category of injury potential and type of 'trigger' scenario

[7] Will trigger a collision between a passenger car (1500kg) driving with 25 km/h and a pedestrian (70 kg) if the vehicle is braking with 7. m/s². Will not trigger a collision between a passenger (1500kg) driving with 85 km/h and a pedestrian (70 kg) if the vehicle is not braking

[8] Will trigger all braking situations with 7.5 m/s². Will not trigger a collision between a passenger (1500kg) driving with 40 km/h and a pedestrian (70 kg) if the vehicle is not braking

[9] Means change in speed without changes due to braking or accelerating with engine force or due to cornering

[10] Vehicle to vehicle and Pedestrian to vehicle communication

Harmful consequences			degree of necessity	Airbag deployment	Other deployable devices	dv >= 8km/h within 150 ms	dv >= 6km/h within 120 ms	dv >= 4km/h within 120 ms 3)	dv >= 2km/h within 120 ms 4)	corr. dv >= 2 km/h within 120 m/s 5)	Standstill	Pedestrian detection	V2V /P2V com. 6)	Noise	Forward sensing	ABS	ESC	Manual (eg. Ecall)	Others
Fatalities	drivers		3	9,0	9,3	8,0	9,0	10,0	10,0	9,5	9,5	2,8	7,0	6,0	5,3	3,3	2,5	1,3	?
	occupants		3	9,0	9,3	8,0	9,0	10,0	10,0	9,5	9,5	2,8	7,0	6,0	5,3	3,3	2,5	2,0	?
	other		3	2,3	2,5	2,5	4,0	5,0	6,0	6,5	8,0	6,3	7,0	6,0	4,7	2,8	2,5	2,5	?
Injuries	drivers	serious	3	9,0	9,3	8,0	9,0	10,0	10,0	9,5	9,8	2,8	6,0	6,0	5,0	3,3	2,5	2,0	?
		minor*	2	5,8	6,0	5,5	6,5	8,0	8,5	8,5	9,3	2,3	6,0	6,0	4,3	3,3	2,5	2,5	?
	occupants	serious	3	8,5	8,0	8,0	9,0	10,0	10,0	9,5	9,3	2,5	6,0	6,0	5,0	3,3	2,5	2,8	?
		minor*	2	5,3	5,5	5,5	6,5	8,0	8,5	8,5	9,0	2,0	6,0	6,0	4,3	2,8	2,3	1,8	?
	other	serious	3	1,5	1,8	2,5	4,0	5,0	6,0	6,5	7,8	6,0	7,0	6,0	4,3	2,8	2,3	2,5	?
		minor	2	0,8	0,8	1,0	1,0	1,5	2,0	2,5	7,0	4,0	7,0	6,0	4,3	2,5	2,0	1,8	?
Damage	host	unusable	3	7,8	7,3	7,5	8,5	9,5	10,0	9,5	9,8	2,5	4,5	6,0	5,0	4,0	3,3	2,0	?
		driveable (not roadworthy)	2	2,0	2,3	2,5	3,5	4,5	6,0	6,0	8,5	2,0	4,0	6,0	5,0	3,5	2,8	2,5	?
		cosmetic	1	0,0	0,0	0,0	0,5	2,5	4,0	5,0	7,0	1,8	3,5	3,5	3,3	2,5	2,0	1,3	?
	other vehicle(s)	unusable	3	6,3	5,3	6,0	7,0	8,0	8,5	8,5	8,0	2,5	7,0	6,0	5,0	3,3	2,5	2,8	?
		driveable (not roadworthy)	2	1,8	2,0	2,0	3,0	4,0	5,5	5,5	7,0	2,3	7,0	6,0	5,0	3,0	2,3	2,5	?
		cosmetic	1	0,0	0,0	0,0	0,0	1,5	2,5	3,0	4,8	1,5	5,0	2,5	1,7	2,0	1,3	1,0	?
	non vehicular property	serious	3	4,5	4,0	6,0	7,0	8,0	8,5	8,5	7,8	2,5	2,0	5,5	4,3	2,8	2,0	2,0	?
		minor	1	0,5	0,5	1,0	1,5	2,5	3,5	4,0	5,0	1,3	0,5	2,5	2,7	2,3	1,5	1,5	?
Unwished Trigger***				0,0	0,3	0,0	2,5	5,5	8,5	2,0	8,7	3,0	5,0	10,0	3,5	6,7	6,7	1,3	?

Trigger Matrix

- wanted (green)
- nice to have (yellow)
- not required (pink)

0 Not triggered
10 Allways triggered

*) without whiplash
***) Remark of Ford to column "corr. dv >= 2 km/h within 120 m/s"; see also *** to fig. 12:

Fig. 8: Accident-event triggering by category of harmfulness and type of trigger scenario

6.1.1.4.5 'Corrected Trigger'

As shown above European accident event recording has to consider also collisions with vulnerable road users, in technical terms 'soft object' collisions. These collisions also include those involving trucks and passenger vehicles which occur typically with low Δv impacts which are difficult to distinguish from hard braking. A solution would be to record them all however storage capacity restrictions and data privacy concerns prevent this. Therefore a more intelligent 'trigger' has to be considered, what we call a 'corrected trigger': "corr. Δv >= 2 km/h within 120 m/s" (see in the table above top line, 7th from left). This 'trigger' reduces the braking impact on the 'triggering'-relevant deceleration curve which originally comprises the deceleration values 'braking plus crash impact'.

A common 'trigger' function will calculate a Δv based on the zero point. For the calculation either a single acceleration channel (for example the longitudinal acceleration) or the resultant acceleration would be used. The resultant acceleration is in this case typically the square root of the square sum of the longitudinal and the transverse (lateral) acceleration. If a defined Δv value is reached, the 'trigger' is fulfilled. For only one channel the following figure shows a standard Δv value:

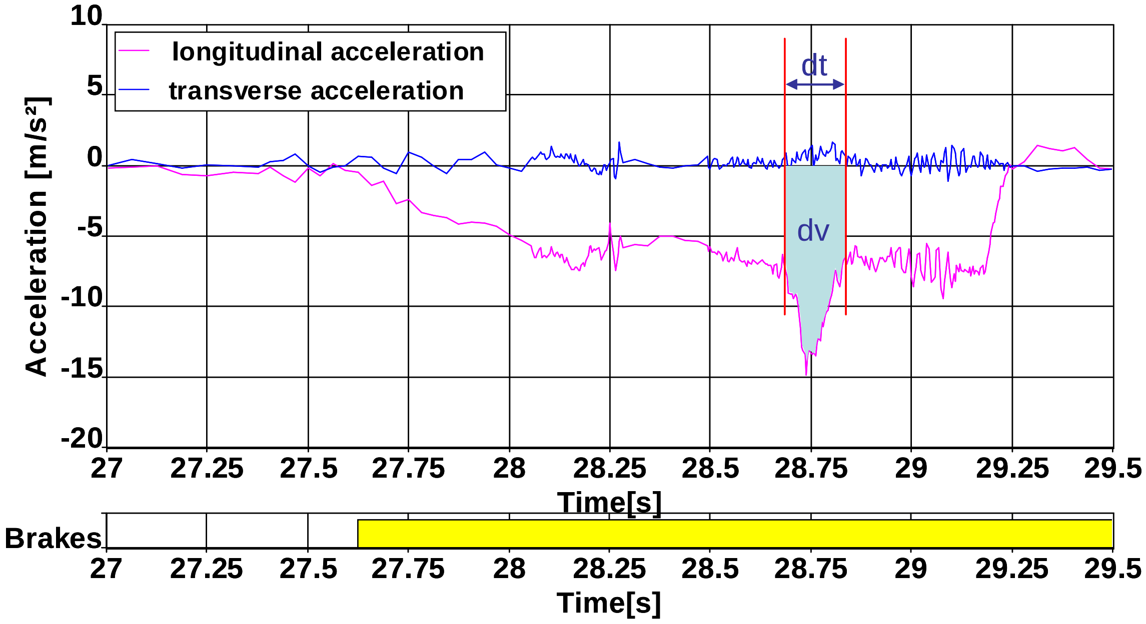

Fig. 9: Example for an uncorrected trigger

The corrected ‘trigger’ function should be based on the resultant acceleration. The base for the Δv calculation is not the standard zero point but the actual average over a defined period of time before and after the possible ‘trigger’ area (see a simple example in next table). This applies to an indefinite number of driving situations and would also minimise the influence of static accelerations like up- or downhill driving or cornering.

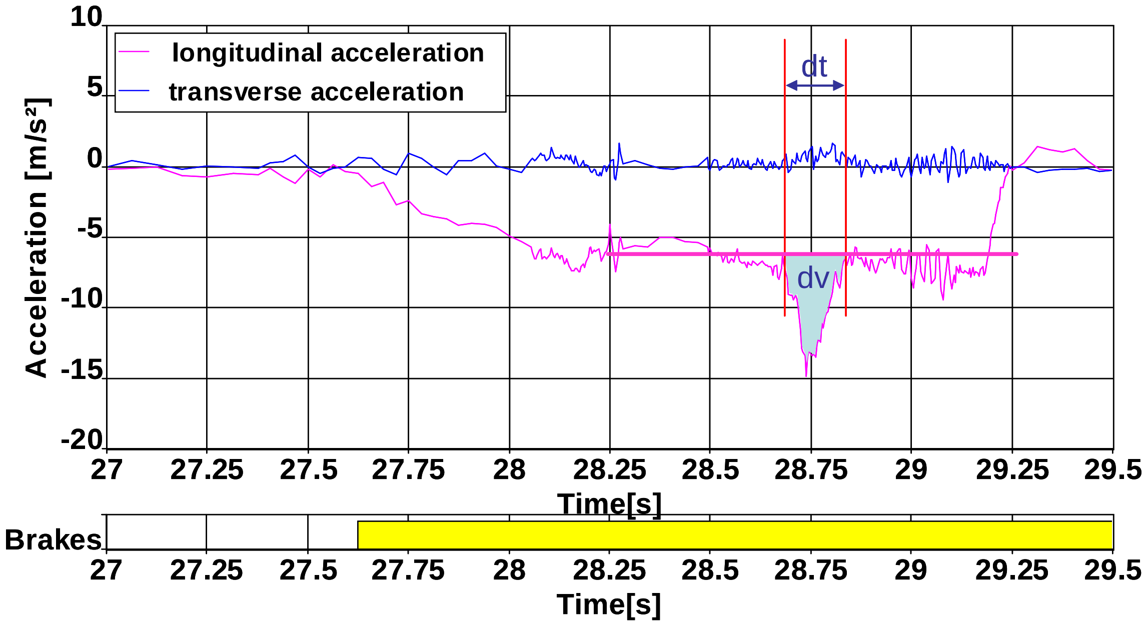

Fig. 10: Example for a 'corrected trigger'

Such a ‘trigger’ algorithm will not exclude all unwanted ‘triggers’, but in comparison to an uncorrected ‘trigger’, it will reduce the number of unwanted ‘triggers’ from 8 to 2 in a scale between 0 and 10 where 0 indicates no unwanted ‘triggers’.

6.1.1.4.6 Prioritisation

In combination with the ‘trigger’ type ‘deployable devices’ that require a higher priority for the ‘deployable devices’ trigger it is important that a maximum number on ‘wanted’ events are allowed; this can be achieved by reducing the number of ‘unwanted’ events to a minimum.

⇨ **By prioritising ‘triggers’ from ‘deployable devices’ it should be possible to keep unwanted ‘triggers’ to a minimum.**

Prioritising means, an event based on a trigger’ type ‘deployable devices’ can overwrite an existing event based on ‘trigger’ type “corr. $\Delta v \geq 2$ km/h within 120 ms”, but an event based on ‘trigger’ type “corr. $\Delta v \geq 2$ km/h within 120 ms” can not overwrite an existing event based on ‘trigger’ type ’deployable devices’. See the following function table:

Overwrites	Existing event class 1	Existing event class 2
New event class 1	no	yes
New event class 2	no	yes

where:

Event class 1: an event based on a ‘trigger’ type ‘deployable devices’
Event class 2: an event based on a ‘trigger’ type ‘corr. $\Delta v \geq 2$ km/h within 120 ms’

Fig. 11: Prioritisation classes

In such a manner a (possibly ‘unwanted’) event class 2 can not block or freeze the device. Events class 2 can be overwritten by new events of any class.

In the case of heavy goods vehicles, a distance based standstill ‘trigger’ will optimise the probability of storing the maximum number of ‘wanted’ events.

Due to the bigger mass of heavy goods vehicles, a collision with a partner of low mass results in a low Δv value. A collision between a truck and a pedestrian, bicycle or motorbike will not be detected as a collision by a Δv based ‘trigger’. A standstill ‘trigger’ helps to close this gap.

6.1.1.5 Consequences for technical event definition

6.1.1.5.1 Ranking of ‘triggers’

The degree of difficulty of the above mentioned ‘triggers’ was ranked (0=Never triggered, 10=Always ‘triggered’) by the members based upon their individual experience, followed by a ‘trigger’ combination matrix and a proposal on the recommended technical consequences.

The result is a list of ‘trigger’ scenarios with what should be within and what should be outside the scope of Veronica-II, in other words a natural priority list **as the key element for the European EDR understanding**.

Based on the matrix above it was agreed that the number of possible ‘trigger’ devices can be reduced as follows to:

Deployable devices [11]

∆v >= 8km/h within 150 ms

∆v >= 6km/h within 120 ms [12]

corr. ∆v >= 2 km/h within 120 m/s

Standstill

Other sensing devices [13]

ABS/ESC

Manual (e.g. eCall)

The column “Maximum values of combination” shows the result of a preferred combination of different trigger types.

Harmful consequences				Trigger Matrix									
						dv							
			degree of necessity	Deployable devices [7]	dv >= 8km/h within 150 ms	dv >= 6km/h within 120 ms [8]	corr. dv >= 2 km/h within 120 m/s [5]	Standstill	Other sensing devices [9]	ABS/ESC	Manual (eg. Ecall)	Maximum values of combination	Average values of combination
Fatalities	drivers		3	9,3	8,0	9,0	**9,5**	**9,5**	7,0	3,3	1,3	**9,5**	9,4
	occupants		3	9,3	8,0	9,0	**9,5**	**9,5**	7,0	3,3	2,0	**9,5**	9,4
	other		3	2,5	2,5	4,0	6,5	**8,0**	7,0	2,8	2,5	**8,0**	5,7
Injuries	drivers	serious	3	9,3	8,0	9,0	9,5	**9,8**	6,0	3,3	2,0	**9,8**	9,5
		minor*	2	6,0	5,5	6,5	8,5	**9,3**	6,0	3,3	2,5	**9,3**	7,9
	occupants	serious	3	8,5	8,0	9,0	**9,5**	9,3	6,0	3,3	2,8	**9,5**	9,1
		minor*	2	5,5	5,5	6,5	8,5	**9,0**	6,0	2,8	1,8	**9,0**	7,7
	other	serious	3	1,8	2,5	4,0	6,5	**7,8**	7,0	2,8	2,5	**7,8**	5,3
		minor	2	0,8	1,0	1,0	2,5	**7,0**	**7,0**	2,5	1,8	**7,0**	3,4
Damage	host	unusable	3	7,8	7,5	8,5	9,5	**9,8**	6,0	4,0	2,0	**9,8**	9,0
		driveable (not roadworthy)	2	2,3	2,5	3,5	6,0	**8,5**	6,0	3,5	2,5	**8,5**	5,6
		cosmetic	1	0,0	0,0	0,5	5,0	**7,0**	3,5	2,5	1,3	**7,0**	4,0
	other vehicle(s)	unusable	3	6,3	6,0	7,0	**8,5**	8,0	7,0	3,3	2,8	**8,5**	7,6
		driveable (not roadworthy)	2	2,0	2,0	3,0	5,5	**7,0**	**7,0**	3,0	2,5	**7,0**	4,8
		cosmetic	1	0,0	0,0	0,0	3,0	4,8	**5,0**	2,0	1,0	**4,8**	2,6
	non vehicular property	serious	3	4,5	6,0	7,0	**8,5**	7,8	5,5	2,8	2,0	**8,5**	6,9
		minor	1	0,5	1,0	1,5	4,0	**5,0**	2,7	2,3	1,5	**5,0**	3,2
Effectiveness [Points]**				**210,5**	**203,5**	**242,5**	**306,5**	**336,0**	**250,7**	**122,3**	**85,0**	**340,5**	**284,3**
Unwished Trigger***				0,3	0,0	2,5	2,0	8,7	10,0	6,7	1,3	**8,7**	3,7
Part of combination				☑	☐	☐	☑	☑	☐	☐	☐		

wanted (factor 3)**	0 Not triggered
nice to have (factor 2)	10 Always triggered
not required (factor 1)	

*) without whiplash

**) Sum of all ratings to the degree of performance multiplied with the degree of necessity

***) Remark of Ford to column "corr. ∆v >= 2 km/h within 120 m/s":

We do not currently have the ability to differentiate between ∆v and corr ∆v. We only have an accelerometer, wheel speed and yaw sensor to measure e.g. speed / acceleration. None of these are sufficient to distinguish between e.g. braking deceleration and crash deceleration - they just see a deceleration. Therefore although in theory the risk of unwanted triggers is low (2), the feasibility of this trigger in the near term is also low and with current technology the risk of unwanted triggers would be high (8).

Fig. 12: Preferred combination of trigger types

[11] Combination of "Airbag deployment" and "Other deployable devices"

[12] columns "∆v >= 4km/h within 120 ms" and "∆v >= 2km/h within 120 ms" removed

[13] Combination of "Pedestrian detection", "V2V /P2V com.", "Noise" and "Forward sensing"

6.1.1.5.2 Conclusions for ‘triggers’:

6.1.1.5.2.1 Combination of ‘trigger’ columns

The discussion revealed that it would be reasonable to reduce the number of ‘trigger’ types by combining them. The columns „∆v >= 4km/h within 120 ms" and “∆v >= 2km/h within 120 ms" were deleted, because compared to „corr. ∆v ≥ 2 km/h within 120 ms" they do not allow a more reliable ‘triggering’ to be expected but introduce a higher certainty of unwanted ‘triggering’ at the same time.

The columns are borne from a combination that a) includes the respective highest value of the singular columns by being aware that the ‘trigger’ security of the individual techniques and b) that the results of the presented evaluation might change in future.

6.1.1.5.2.2 Result

The column ‘Deployable devices’ shows the lowest risk of recording ‘unwanted’ events. In parallel the risk of not recording ‘wanted’ events is comparatively high. A good performance shows the column “corr. ∆v ≥ 2 km/h within 120 ms“, with a still acceptable risk of ‘unwanted’ ‘triggering’ (see above in fig.8: footnote *** by Ford). Also a good performance shows how the standstill ‘trigger’ is highly likely to incorporate ‘unwanted’ ‘triggerings’ that have been derived from this definition of the ‘triggering’ (i.e. recording at every standstill). It seems therefore very plausible to combine several of the ‘triggers’ and prioritise them accordingly. The highest priority is attributed to the ‘trigger’ with the lowest risk of ‘unwanted’ ‘triggerings’. The diagram shows the combination of three ‘trigger’ levels:

1. **‘Deployable devices’; for commercial vehicles without ‘deployable devices’ a comparable ‘trigger’ property is recommended, i.e. ∆v ≥ 8 km/h within 150 ms**
2. **corr. ∆v ≥ 2 km/h within 120 ms**
3. **Standstill**

Additional ‘trigger’ levels are not ruled out (e.g. corr. ∆v ≥ 4 km/h) and may be implemented by a manufacturer.

‘Deployable devices’ and “corr. ∆v ≥ 2 km/h within 120 ms” share the three areas described further above for the last three ‘wanted’ events whereas the trigger type ’deployable devices’ can overwrite the ‘trigger’ type “corr. ∆v ≥ 2 km/h within 120 ms” but not vice versa (prioritisation). The ‘standstill trigger’ should record in a separate area a certain time distance related to the actual moment which is defined in figure 33 and according to the data element definitions. A standstill is a zero-speed information for at least 5 seconds.

6.1.1.6 Practical ‘soft object’ collision examples

6.1.1.6.1 Collision between an emergency vehicle and a pedal cyclist in a pedestrian zone

Pedal cyclist was killed and severe damage caused to vehicle and bicycle (arrows in picture below); the vehicle driver claims that pedal cyclist did not hear vehicle horn as cyclist was listening to iPod-music on earphones. Crash recorded by European type

ADR (in chart below from top to bottom: acceleration and deceleration, speed, status information). NHTSA EDR would not have been ‘triggered’ because linked to airbag, which did not deploy.

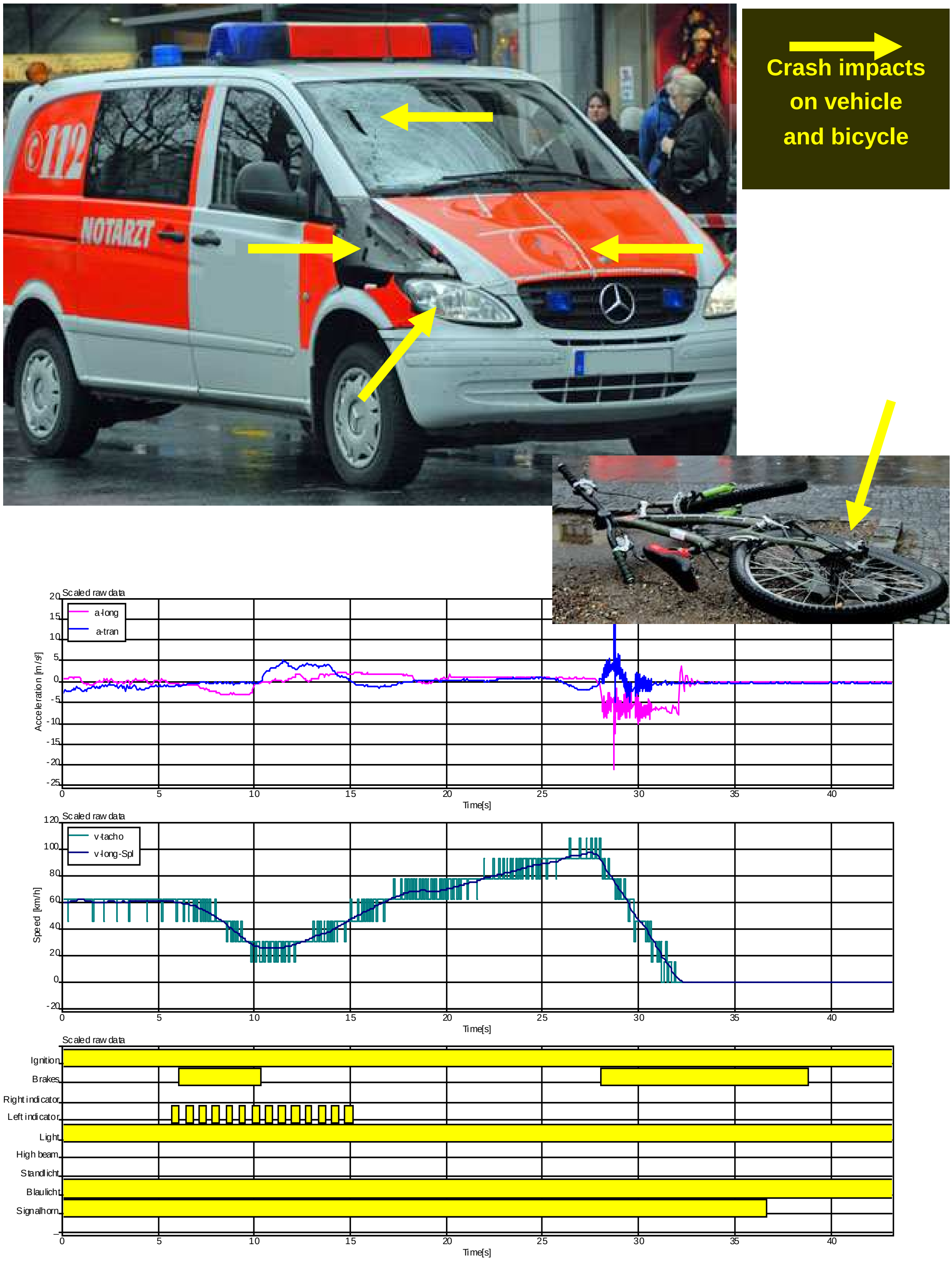

Fig. 13: Collision between an emergency vehicle and a pedal cyclist in a pedestrian zone

6.1.1.6.2 Collision between a bus and a pedestrian

Pedestrian crossing from the left, crashing with her head into windscreen, fatally injured; police suspicion that bus had set right indicator to stop at a bus stop thus misleading the pedestrian into thinking that it was safe to cross the street was rebutted by ADR recording; ‘triggered’ automatically and by ‘standstill trigger’; NHTSA standard ‘trigger’ would not have recorded the crash (soft object and no airbag in bus anyway) and neither indicator 'yes' or 'no' as the NHTSA standard does not require this data element.

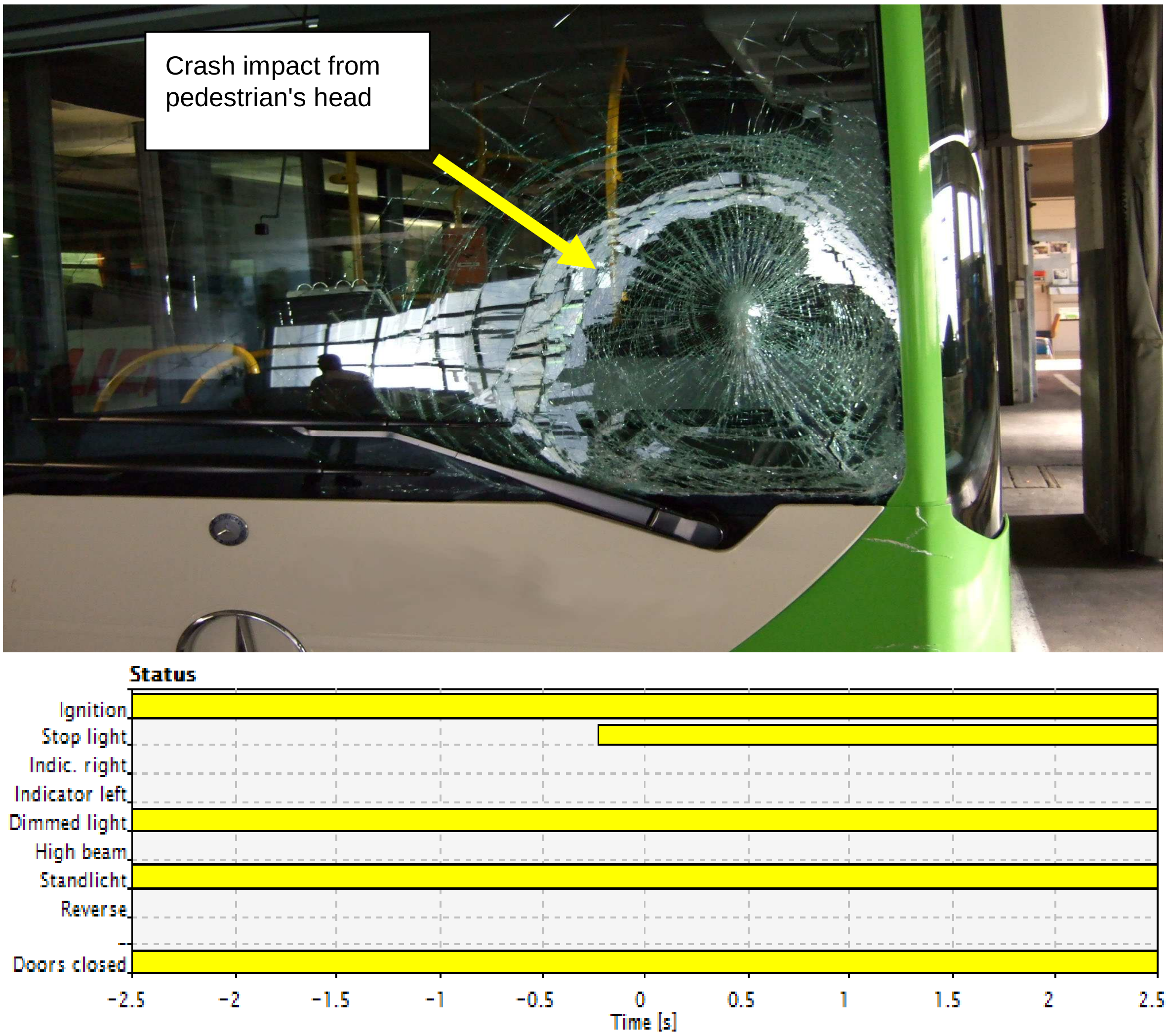

Fig. 14: Collision between a bus and a pedestrian

6.1.1.7 Conclusions for Event Definition

- ⇨ **If EDR data is to be used to comprehensively enhance road safety the event definition also has to include the detection of the so called ‘soft object’ collisions, i.e. collisions with vulnerable road users. Their share among road victims is considerable and should not be neglected.**
- ⇨ **In order that EDRs can record such collisions a ‘trigger’ specification is required which goes beyond the air-bag related NHTSA specifications as these only focus on the protection of the vehicle occupants and not on road users outside the vehicle.**

These recommendations were not unanimously agreed upon. Ford Motor Company provided the following comment: *"In theory we do not object to including vulnerable road users in the specification of EDRs but we have expressed doubts about the feasibility of doing so, especially in terms of sensor capability and memory capacity. We believe that the greatest benefits can be gained by wide spread deployment of EDRs based on technology already available on vehicles but which is not currently capable of robustly recording low delta-v impacts".*

Other project partners argued that including collisions with vulnerable road users in the scope of European EDRs might increase the demands placed on vehicle manufacturers in meeting these requirements. Reference was made to the observation that at least one US OEM has on a voluntary basis already gone beyond the NHTSA Standard.

The following information, data files and a photo were provided by the Dutch Police. They document an accident which involved a Chevrolet Chevy Van ambulance and a pedestrian who failed to register the approaching ambulance with the emergency siren and blue lights switched on. The Airbag Sensing & Diagnostic Module (SDM) 'triggered' the recording of a soft object collision under conditions which the NHTSA standard does not require.

Fig. 15: Impacts from a collision between an ambulance and a pedestrian

BOSCH CRASH DATA RETRIEVAL SYSTEM

CDR File Information

Vehicle Identification Number	1GCGG25U571141197
Investigator	Bot
Case Number	2008 397884-3
Investigation Date	maandag, december 1 2008
Crash Date	zaterdag, november 29 2008
Filename	2008 SPINOZAWEG.CDR
Saved on	maandag, december 1 2008 at 09:07:39
Collected with CDR version	Crash Data Retrieval Tool 3.00
Reported with CDR version	Crash Data Retrieval Tool 3.00
EDR Device Type	airbag control module
Event(s) recovered	Non-Deployment

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Non-Deployment	10835
Ignition Cycles At Investigation	10841
Maximum SDM Recorded Velocity Change (MPH)	-1,57
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	130
Crash Record Locked	No
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	30	2304	29
-4	33	2304	29
-3	35	2240	29
-2	37	2240	29
-1	38	2240	7

Seconds Before AE	Brake Switch Circuit Status
-8	OFF
-7	OFF
-6	OFF
-5	OFF
-4	OFF
-3	OFF
-2	OFF
-1	OFF

Fig. 16: Data sheets from a collision between an ambulance and a pedestrian

The table shows a “Maximum SDM Recorded Velocity Change (MPH)” of 1.57 within 130 ms (2.53 km/h within 130 ms), whereas the NHTSA Final Rule[14] requires: "*Trigger threshold means a change in vehicle velocity, in the longitudinal direction, that equals or exceeds 8 km/h within a 150 ms interval*". This real ‘trigger’ is very close to the ‘trigger’ definition proposed by VERONICA II.

The example shows the possibility to ‘trigger’ events where the acceleration or deceleration in average is significant below 1 g (here 0.55 g over 130 ms).

[14] Federal Register /Vol. 71, No. 166 /Monday, August 28, 2006 /Rules and Regulations page 51045

6.1.2 Data use outside the vehicle

6.1.2.1 Introduction

This chapter sequentially follows Event definition and is closely linked to the next deliverable whose objective is to assess data privacy issues. This chapter aims at giving overviews of different Administrative Data Flows (ADF) within the EU, or EEA countries.

1. This work is based on the information collected through project meetings and external workshops and congresses which CORTE as the WP leader organised and/or attended, as well as through its membership. It is aimed at evaluating the need for event data use outside the vehicle and in particular for research purposes and giving an overview of national ADF schemes. CORTE developed a questionnaire to be completed by its membership so as to provide VERONICA II with feedback from national authorities on several Administrative Data Flows. Additional sources of information such as reports have also been used to complement the information provided otherwise.

2. The choice of France, the Netherlands, Norway, Sweden and the United Kingdom was based upon the fact that they demonstrate examples where ADFs have been implemented at national level and have developed public policies for road safety and/or can also rely upon the commitment of the car manufacturers or other private actors to improve R&D activities related to road safety. The UK, for instance, has institutionalised recourse to R&D laboratories and various projects that have been set up to attain a more efficient policy for road security. France strongly relies upon research undertaken by public bodies and also a joint-venture set up by the groups Renault and PSA. In Sweden, the “Zero Vision Policy” makes everyone responsible for improving road security, etc.

3. This chapter also highlights the structure of the Administrative Data Flow within selected Member States of the European Union with accompanying general facts and recommendations to enhance data security, especially when put into the perspective of data privacy concerns.

4. The need to develop and implement an Event Data Recorder (EDR) originates from the European Commission (EC) DG TREN White Paper on Transport issued in 2001, which sets the objective to halve the number of road transport victims by 2010. Amongst the various useful means to meet this target, the white paper encourages a broader implementation “*of black boxes to record parameters which help explain the causes of accidents, will make motorists more responsible, speed up court*

proceedings following accidents, lower the cost of court proceedings and enable more effective prevention measures to be taken[15]."

5. Despite the fact that EDRs can contribute to enhance road safety, it must be clearly stated that an EDR is not *per se* a prevention tool because the data it records relates to events that have already occurred. Indeed, the overall objective of an EDR is to provide information to either investigate where responsibilities lie in the event of an accident, therefore contributing to support the legal process, or to support research in the field of road safety. The VERONICA I project has stressed added-value of EDRs to road safety. EDR will provide information related to the status of the vehicle in the context of an accident thus enabling an assessment of the driver's behaviour as well as improving the infrastructure, driver training and active and passive vehicle safety. This raises the question to know how the EDR extracted data will potentially be used within the "Administrative Data Flow" (ADF).

6. Consequently, this deliverable on "data use outside the vehicle" aims to offer an overview of how EDR data can potentially be used. For this purpose, the document is articulated around three parts, respectively providing an overview of an EDR, presenting the different stages of the ADF and stakeholders involved, and finally detailing several ADF within five EU Member states.

6.1.2.2 Overview of an EDR

6.1.2.2.1 EDR and Road Safety

1. Event Data Recorders can be defined as follows: "*The accident data recorder is an on-board event recorder. In case of accidents (or events) data on the vehicle's speed, acceleration, brake use, etc. just prior to, during and after the accident are recorded. These data can subsequently be downloaded from the accident data recorder and used to analyse how the vehicle was driven at the time of the accident. This knowledge can serve scientific, technical and legal purposes.*"[16]

2. An EDR consists in a Sensor Data Buffer which permanently receives data from sensors. This implies that data is permanently overwritten with new data. Under specific conditions of the status of the vehicle, i.e. once a certain threshold of event severity is reached, the EDR freezes data in the Sensor Data Buffer so that, if an event effectively occurs, data is kept available and can be extracted to be used for investigation or research. The frozen data, as defined by the VERONICA project, covers the last seconds before (approx. 30 seconds) and after (approx.15 seconds) the accident-event occurred. After the event occurred, data downloaded from the EDR can be collected for analysis to ascertain the causes of the accident.

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[15] White Paper on Transport, 2001, http://ec.europa.eu/transport/white_paper/documents/doc/lb_texte_complet_en.pdf

[16] European Commission (2005). *Cost-benefit assessment and prioritisation of vehicle safety technologies*. European Commission Directorate General Energy and Transport: Final Report.

3. EDR represents an important monitoring and research tool for road safety therefore there is a imperative to ensure better in-depth and real-life data; the requirement for mandatory EDRs has recently been highlighted by the "Expert Group on Accidents in the Transport Sector" (2006)[17] as well as on the European Road Safety Observatory (ERSO) Congress in Rome, April 2008. EDRs are regarded as particularly efficient in:

- Increasing accuracy and quality of accident data, thus enhancing accident reconstruction;
- Evaluating new safety technology;
- Improving the design of a crashworthy road transport system;
- Better understanding the causes and mechanisms of injuries;
- Speeding up and refining legal processes;
- Enhancing pre-crash investigation and crash reconstruction;
- Enhancing driver training and infrastructure enhancements.

4. In parallel to the use of EDR as an enforcement device, the most important direct effect of EDR in terms of road security concerns driver behaviour i.e. a driver can be expected to modify his behaviour accordingly knowing that traffic law infringements can, in principle, be detected if an ‘accident-event’[18] should occur;.

5. A cost-benefit assessment and prioritisation study of 21 vehicle safety technologies conducted for the European Commission in 2005 and based on a wide range of EDR field examples and studies concludes for the scenario of a broad accident data recorder implementation an average reduction of collision probability of 10% for fatalities as well as for serious and light injuries. Benefits are estimated to outweigh costs by a factor 7. For all the values used in the sensitivity analyses, benefits exceed costs. Thus Event or Accident Data Recorders figure as number 2 among the most cost effective road safety technologies[19] According to the findings of VERONICA I (2006), the behaviour change can minimise the risk and severity of accidents and reduce repair costs by up to 25%. This is in particular true for drivers operating under fleet, working shift or insurance conditions. The deliverables of the PRAISE Project initiated by DG Tren in June 2009 will come up with examples on safety benefits in an occupational road safety environment.

In the VERONICA-I project framework it had been agreed to collect the following data:

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[17] ROAD ACCIDENT INVESTIGATION IN THE EUROPEAN UNION REVIEW AND RECOMMENDATIONS, Report from the Road Sector Working Group to the Plenary, May 11th, 2006

[18] As defined in VERONICA I : «Accident' means an unwanted or unintended sudden event or a specific chain of such events which have harmful consequences.”

[19] European Commission (2005). *Cost-benefit assessment and prioritisation of vehicle safety technologies*. European Commission Directorate General Energy and Transport: Final Report., p. 142 seq. (144) and p. 8, http://ec.europa.eu/transport/roadsafety_library/publications/vehicle_safety_technologies_final_report.pdf

No	Recorded data	Explanation
1	**Collision Speed**	**Speed at moment of impact**
2	**Initial Speed**	**Speed at start of recording a/o braking**
3	**Speed Profile**	**Pre- and Post crash**
4	**Change in velocity due to a collision**	**Δv = Delta-v = Change in velocity due to a collision**
5	**Longitudinal acceleration (IP)**	**Impact phase (high resolution)**
6	**Transverse acceleration (IP)**	**Impact phase (high resolution)**
7	**Longitudinal acceleration**	**Pre- and Post crash (low resolution)**
8	**Transverse acceleration**	**Pre- and Post crash (low resolution)**
9	**Yawing**	**Pre crash yawing**
10	Tracking	Displacement tracking of collision sequence.
11	Position	Absolute position
12	**Status Signals**	**Brake light, indicator, lights, blue light, horn ...**
13	**Trigger Date and Time**	**Convertible into real time after download**
14	**User Action**	**Throttle, brake, steering, horn, clutch ...**
15	**Monitoring Restraint Systems**	**Airbags, Seat Belts**
16	**Monitoring Active Safety Devices' actions**	**Active Safety Devices (ESP, brake assistant, ABS) go/no-go self-diagnosis for exoneration purposes of manufacturer**
17	**Monitoring displayed Active Safety Devices' error messages**	**Messages on faults of ABS Systems etc for exoneration purposes of manufacturer**
18	VIN/VRD	Vehicle Identification No/Vehicle Registration No
19	Driver-ID	Key, Smart Card, Code ...
20	Monitoring Driver	Visual Monitoring

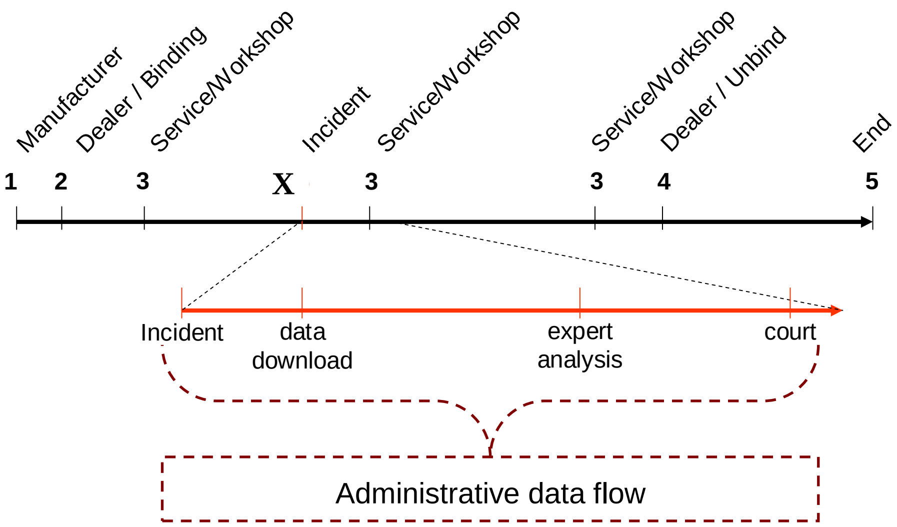
- General agreement for enforcement, insurance and rescue purposes
- Secondary importance
- Useful only for specific purposes

Fig. 17: Agreed data elements and their importance

6. The Work Package 2 Leader and the Project Manager of Veronica II attended a conference of the European Road Safety Observatory (ERSO) held on 17 and 18 April 2008. The conference pointed to the fact that road safety is a shared responsibility; all stakeholders, including those from the research side should consequently contribute to an approach that sees the integration of vehicle, infrastructure and behaviour of users as paramount. When it comes to a global approach of Road safety; EDR should definitely be apprehended as a crucial item for enhanced safety. Indeed, an EDR concerns the vehicle itself, but also infrastructure and drivers' behaviour as shown above.[20]

6.1.2.2.2 Overview of the EDR life cycle

1. The following scheme presents the EDR's life cycle assuming that an accident-event occurred, thus 'triggering' the freezing of data. This life cycle has been defined in the frame of the VERONICA II project (see 6.2.4.3.1).



- Manufacturer (1): The EDR is manufactured (or reset to its factory defaults). This may include assigning a unique ID for the EDR;
- Dealer / Binding (2): In this phase of the life-cycle, the EDR is bound to a vehicle. This step is similar to the personalization of a smart card and may include entering the vehicle's VIN into the EDR memory;
- Service / Workshop (3): In this phase, a workshop gets access to the EDR during its normal maintenance cycle and eventually tests the EDR to operate correctly;
- Dealer / Unbind EDR (4): When an EDR is removed from a vehicle, the EDR binding data is removed or replaced with data of another vehicle it is fitted to (in this case, this phase is similar to stage 2 of the life cycle;
- EDR end of life (5): This is the end of the EDR life cycle with the EDR being decommissioned;
- Incident Crash-event (**X**): This is the purpose for which EDR was designed. When a crash-event occurs, EDR data can be used to analyse the incident.

Fig. 18: EDR life cycle and Administrative Data Flow

[20] For further information please refer to VERONICA II interim report (14-07-2008)

These reflections focus onto EDR data related issues within any of the phases “3” after an event “X” has occurred.

6.1.2.2.3 Overview of possible data threats during the Administrative Data Flow

Through the EDR lifespan, the following generic threats to EDR data have been identified in the frame of this project (for details see further below under 6.2.4.3.2).

6.1.2.2.3.1 Confidentiality

Conclusions drawn from project workshops and external sources suggest that there are hardly any realistic threats to confidentiality of EDR data. Nevertheless, adopting a limited view, the data might be regarded as personal because investigation usually leads to a person. The consequence is that the confidentially issue and resulting privacy concerns must be taken into consideration for the Administrative Data Flows whose managers usually know the legal processes of dealing with personal data.

6.1.2.2.3.2 Integrity

Threat to data integrity implies manipulation in order to evade legal prosecution and/or financial measures from insurances companies. Once again conclusions drawn from the workshops and symposiums suggest that there are hardly any realistic threats to the integrity of EDR data. In this regard, the integrity of EDR data will serve the objective to assess where responsibilities lie and to understand what happened. Understanding the circumstances in which an event occurred meets the objective to enhance road security as mentioned in the DG TREN White Paper and support public or private interests.

6.1.2.2.3.3 Availability

Similar to integrity in terms of consequences, the availability simply consists in the property of EDR data to remain both accessible and usable when needed.

6.1.2.2.3.4 Authenticity

This refers to the origin and genuineness of data. To be of proper use EDR data must have originated from the relevant vehicle and must not have been tampered with in any way. Any identified threats to EDR data should be taken into special consideration at the very beginning of the Administrative Data Flow, i.e. as soon as the EDR data has been frozen and extracted until sealed as evidence or sent to potential stakeholders (as detailed below). This timeframe is referred to as ‘the window of opportunity’.

6.1.2.2.4 User profiles within the EDR data Administrative Flow

1. EDR data, along with other accident data, is used for two main purposes:

- Judicial issues (criminal, private)
- Research
- Enforcement

For enforcement to be effective immediate action after an accident will make it easier to determine the guilty of a driver(s) and general enforcement of the traffic rules. A crash-free control of compliance with traffic rules is hardly possible (exception: manually ‘standstill trigger’ for special situations) nor within the event definition of the VERONICA projects.

2. Consequently, during the ADF, EDR data will be circulated amongst bodies representing various interests, either public or private. As there is no standard ADF, this heterogeneous aspect is important in the sense that the ADF and all potential related-issue, such as data privacy, result from different public policies for road safety implemented by Member States. As a consequence, the overall ADF may differ from one Member state to the other, implying for example the participation of 4 different Ministries in one Member state, whereas only one is implied in other Member states.

3. In addition there will be considerable variations in EDR data content as this is wholly dependent upon the vehicle manufacturing industry’s involvement since the experience shows that industry is increasingly committed to enhancing road safety. Latest observations in the US reveal that at least one car-maker has started to release vehicles to the market which provide EDR functionalities above the standard required by the NHTSA.

4. The various stakeholders can be divided into two groups having public or private interests as presented in the scheme below:

EDR data stakeholders

Public interests

- Road Transport / Traffic
- enforcement authorities
- Tribunals and Courts
- National policy makers and regulators
- European policy makers and regulators
- International policy makers and regulators

Private interests

- Drivers
- Lawyers
- Insurance companies
- Vehicle workshops
- Vehicle manufacturers
- Vehicle industry
- Automotive industry
- Rental companies
- Transport companies / companies operating vehicles

Joint Private and Public interests

Collision experts, accident investigation, research bodies and third parties

Fig. 19: Stakeholders and their interests

5. Throughout the overall ADF, 14 potential stakeholders should be identified because they can directly intervene on EDR data, or because they have particular interests to use or only access EDR extracted data. Identified stakeholders are:

- Courts & lawyers;
- Collision Experts;
- Drivers;
- Organisations running accident database;
- Police;
- Research entities;
- Vehicle Workshops & vehicle manufacturers;
- Vehicle and automotive industry;
- Lease companies;
- Transport companies / companies operating vehicles;
- Third Parties (accident victims).

6.1.2.2.5 Global view of an Administrative Data Flow

The chart below provides an overview of what could be a standard Administrative Data Flow for EDR data, regardless of any EU Member States context.

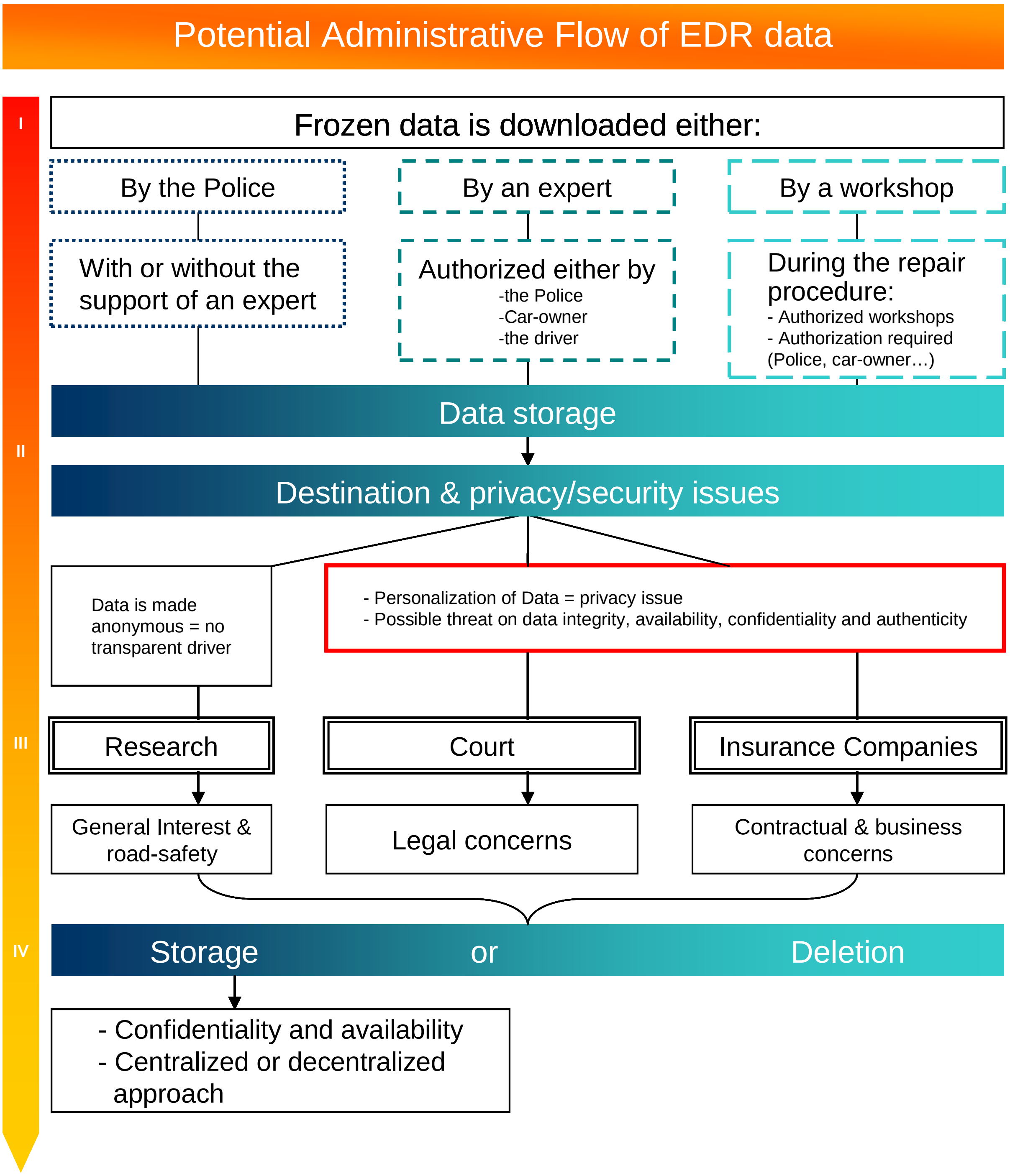


Fig. 20: Potential administrative data flow

6.1.2.3 The Administrative Data Flow

The Administrative Data Flow starts when EDR frozen data is collected either by Police forces or accident reconstruction experts and covers every step until data is stored or deleted. These steps cover:

- Data collection;
- Data storage;
- Data usage.

6.1.2.3.1 Data collection

Data is downloaded either by the Police, collision experts or vehicle workshops.

6.1.2.3.1.1 Police

1. within the EDR data framework law enforcement authorities, including Police forces at national and local levels, are the first agencies to intervene, thus initiating or not the investigation of the ADF of EDR data. As Police has the obligation to maintain public security and to investigate civil and criminal actions this also includes accidents and crimes related to road safety.

2. In most cases, police forces collect data *in situ*, i.e. where the accident occurred. However, when it comes to EDR data, collection of data requires specific technical expertise. As a consequence, Police forces can mandate a collision expert to collect the necessary data on their behalf. To conduct a proper investigation police forces need as much data as possible related to a specific collision or crime and to the identified or identifiable person involved. This data needs to be easily comprehensible to be used as quickly as possible.

3. The storage period outside the vehicle varies from one Member State to another since it depends on whether there are legal provisions regulating this issue. Furthermore, when legal provisions exist, they are based on national laws, which are also different from one Member State to another.

6.1.2.3.1.2 Collision experts

1. As stated earlier, collision experts might represent either private or public interests. They are often the first stakeholders to handle EDR data as their expertise routinely requires careful assessment and interpretation of the EDR data. The QUERY[21] reports stresses that the services of Accident Reconstruction Experts are generally requested by the prosecutor or the police following an accident. The investigative activity of Accident Reconstruction Experts depends strongly upon on how vehicle accidents are usually managed. For instance, in France, the market for

[21] The QUERY report on the EVU website: http://www.evuonline.org

accident reconstruction expertise is somehow limited because quite often an amicable settlement is favoured instead of a judicial approach. This situation, however, only reasonably applies to accidents with limited financial or structural consequences.

2. Currently there is no European certification scheme in existence since enforcement related-issues often remain in the scope of individual EU Member States national competences. Several countries, however, share a similar organisation in relation to certification of Accident Reconstruction Experts. For instance, in Germany, accident reconstruction experts are certified by the Regional Chambers of Industry and Commerce. The prerequisites to be given the title of a "Sworn Accident Reconstruction Expert" concern both the academic background and the professional experience. In France, however, there are no specific qualifications required to be considered an Accident Reconstruction Expert and therefore it is not a regulated profession. Nevertheless before an expert can be listed and thus recognised by tribunal and courts as legal experts his/her application is analysed in depth by the President of several chambers. In other countries EDR data is most likely to be handled by experts within police forces where the issue of mandate/certification and integrity is not as relevant as it is in most of other EU Member States.

3. At a wider concern, the QUERY report shows that in eleven EU Member States there is no certification system for accident reconstruction experts (LV, SI, DK, SE, FI, IT, ES, FR, GB; PT, BE).

4. Finally, the issue of qualification raises the important issue of terminology. For instance in France the generic word for the profession in question is "*accidentologue*", whereas accident reconstruction is only a very specific dimension of "*accidentologie*" (i.e. study of accidents). Accident Reconstruction Experts or "*Accidentologues"* pursue an unregulated profession, whereas the profession called "*Experts en Automobile"* (automotive experts) is regulated.

6.1.2.3.1.3 Vehicle workshops

1. During the data collection process, it is worthwhile considering that under specific circumstances, EDR data could be downloaded by workshops, or data could be simply collected within a workshop by the police or reconstruction experts. In such a case, workshops would be acting either on behalf of a public authority, or at minimum, under its supervision. Workshops could also extract EDR data upon request of the car holders and drivers.

2. However, workshops usually do not have the necessary equipment to proceed to EDR data extraction, and even less the training and experience to analyse data. Taking into consideration the various threats and challenges to EDR data integrity, workshops could only extract EDR data on condition that they are given a legal

authorisation by public authorities to proceed to EDR data collection. Thus only certified/authorised workshops could deal with EDR data.

3. In conjunction with the data collection process workshop expertise is more likely to be devoted to providing assessments of vehicle damage however their reports can complement reconstruction experts EDR data analysis.

6.1.2.3.2 Intermediate Data Storage

1. This stage is a middle-step of the ADF since it primarily concerns temporary storage, if any, which intervenes between data collection and use of data either for legal, research or private interests. This duration and extent of this step may vary depending on the national legal framework ruling the ADF. Intermediate data storage should not be dealt with differently from final data storage as data should remain both secure and available at middle-stage.

2. As EDR data can be extracted by several agencies and mainly public authorities, i.e. police forces, the issue is to determine the most suitable way to ensure safe provisory data storage and also ensuring data availability and security. EAID experts have recommended a decentralised solution for the data handling issue. At this stage of the ADF, this recommendation may introduce potential constraints resulting from various EDR data use that could arise after *in situ* collection as it could limit the number of intermediate stages between data collection and data analysis/use phases.

3. Considering that the ‘window of opportunity’ takes place precisely before the data is analysed and sealed, a decentralised solution may theoretically multiply the number of opportunities for ex-post tampering of data. The need to balance the necessity to ensure both integrity and security of data with its availability is potentially at stake. Indeed, whereas data privacy issues would probably lead to a decentralised approach, a centralised approach can potentially enhance data integrity. This unbalanced situation might lead to measures being introduced to ensure both data privacy and integrity issues, such as an efficient traceability system that will allow and audit trail of potential integrity breaches over EDR data were a decentralised approach implemented. Scenarios elaborated within this project (D 3-05) revealed that because of the number of data elements and channels, the complexity of the data generated in an accident and the interfering logics between them, the practical relevance of data tampering is minimal.

4. Depending on whether a centralised or decentralised approach is chosen, the data storage phase may strongly impact the next phases of the Administrative Data Flow.

6.1.2.3.3 Potential EDR data usage

As stated earlier, EDR will primarily be used either for public interests (research and legal issues), or for private interests including insurance companies and car-makers industry. The question is therefore to assess how and when potential stakeholders may access or not EDR data.

6.1.2.3.3.1 Research and reconstruction activities

1. The ERSO conference in Rome in April 2008, amongst others, has confirmed the interest and relevance of EDRs to improve research and in-depth studies on road safety. Pete Thomas, Loughborough University, supporting a theme developed by other speakers stressed the need for data about accidents, with the natural consequence that in-depth studies are a prerequisite. The representative of the UK Department for Transport endorsed? a previous statement and declared that understanding the causes and consequences of road accidents is the very cornerstone of their "evidence-based approach to road safety". EDR data is a potentially strong asset for enhanced in-depth research and should therefore play a more prominent role in future EC actions.

2. If the use of EDR data for research and reconstruction activities is relevant, such activities should take into consideration the fact that using EDR data might imply a suggestion that they will be tested against data privacy regulations. Considering that EDR data can have a certain status? though practically limited relevance for data privacy. Once extracted EDR data has to be either modified in order to avoid any possible subsequent linkage with the concerned driver or handled in a practical way so as to prevent possible breaches of data privacy laws.

3. EDR data can be modified without being altered either by anonymisation (deleting direct identification data) or pseudomisation (giving a new name to data). It was stated during the conference of European Statisticians on Statistical Confidentiality and Access to Microdata held in 2003 that "*anonymisation process decreases the value of the data*". However, anonymisation or pseudomisation of EDR data should not impact researches conducted on road safety issues, which mainly relies upon data related to the structural and dynamic status of the vehicle.

4. As far as research activities are concerned special attention should be paid to ensure that de-anonymisation is impossible through the connection of different information. For example researchers from public or private bodies do not need personal data to do their research activities and raw EDR data useful for specific purposes will be sufficient in most of the cases. In the situation where further researches are done, the collection of additional data may constitute a potential bridge to the driver's identity. In this occurrence data should be deleted between the collection phase and the moment it is used by researchers.

6.1.2.3.3.1.1 Research and data privacy issues

1. As shown above, EDR is relevant to support research activities to support and enhance public policy for road safety.

2. For any research purposes, data must be made anonymous or pseudomised as long as this process does not impact or tamper the expected research outputs. Indeed, for specific cases like in-depth or life-long research, exceptions could possibly be permitted.

3. Databases are amongst the main sources of information for data users, although data can often be transferred either by public authorities or by insurance companies. When it comes to the EDR, one of the main added-value of its data is to provide a picture of a vehicle's status when an event occurs. The development of the CARE database brings a perfect example of the EDR added-value.

4. Finally, the benefits of EDR data for road safety improvement are put forward by RO-SAT (Road Strategy Accidents in Transport)[22], which, in its report on Road Accident Investigation in the European Union[23] "calls for the promotion of EDR for independent accident research because of their great potential to obtain detailed information on accident circumstances".

6.1.2.3.3.1.2 The CARE database

1. The development of CARE has its roots in the fact that EU Member States collect data related to road accident using their own national collection systems. At European level, road accident data has been available since 1991 in disaggregate form in CARE, which comprises detailed data on individual accidents as collected by the Member States[24] on a voluntary basis.

2. The lack of uniformity of data collected by EU Member States and further used to feed the CARE database hinders the exploitation of CARE potentials and limits data analysis and comparisons at EU level[25]. This lack of uniformity is precisely the reason behind the recommendation for a Common Accident Data Set (CADaS), which objective is to standardise a minimum set of data so as to get comparable road accident data, hence getting rid of limits currently affecting CARE. Gradually, the CADaS protocol[26] will allow more and more national data to be put together within the CARE database. EDR data is perceived as useful additional data to further

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[22] The RO-SAT working group is a subgroup of the *Group of Experts to advise the Commission on a Strategy to deal with Accidents in the Transport Sector.*

[23] http://ec.europa.eu/transport/roadsafety_library/publications/rosat_report.pdf

[24] Recommendation for a Common Accident Data Set, version 2.0

[25] Ibid.

[26] Which last version was delivered by the end of 2008 to the European Commission

populate the CARE database, thus also backing the analysis and conclusions that can be drawn out of the database. The scheme below shows the future accident data collection process[27]:

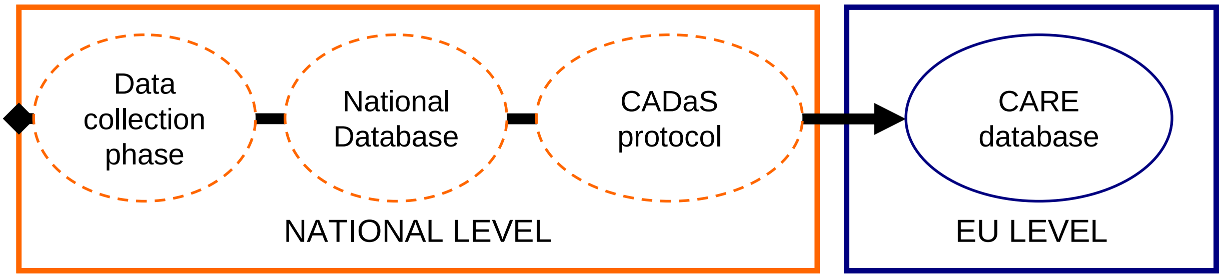

Fig. 21: Future data collection process

3. This scheme also illustrates the specificity of the CADaS protocol, where EDR data can be handled both at national and European levels, implying a possible duplication of data between the national and European levels. The transformation of data at national level should not generate any additional risk of data security and integrity breaches. Moreover, once data is in the CARE database, there are no obvious benefits for any of parties to alter data.

4. The CARE database has been presented by Professor Yannis (National Technical University of Athens) during the ERSO conference. He also, like other speakers, highlighted the need for more in-depth and real-life data and he also indicated that CADAS could easily accommodate this data since CARE is designed so as to accept both high and low resolution data.

6.1.2.3.3.2 Judicial circuit

1. Contrary to researchers situation the actors and agencies involved in the judicial process of assessing responsibility of an accident need as much data as possible related to a specific person. Anonymised EDR data would be of very limited use in the judicial process and in that regard there is no obvious reason for which data privacy rights should supersede public order and crime investigation.

2. Although the data privacy issue is of primary importance when it comes to the judicial process availability should also be put forward since multiple actors as prosecutors and lawyers are susceptible to require EDR data.

3. In the end, EDR data used in the judicial process should not be altered at all.

[27] More information can be found here on the website of the European Commission: http://ec.europa.eu/transport/road_safety/observatory/statistics/care_en.htm

6.1.2.3.3.3 Enterprise and Industry

Private interests are mainly represented by car-makers and insurance companies:

- Car-makers use EDR data either to:
  - ⇨ improve research on the vehicle's safety;
  - ⇨ or seek for evidence to prove there was an absence of malfunctioning in their cars e.g. accidents potentially caused by speed regulators dysfunction – Seat, Renault, VW.
- Insurance companies use EDR data to solve points at issue between them and insured parties. In such case, personal data is required.

6.1.2.3.3.4 Use of data for EDR stakeholders

The EDR is a tool of primary importance to protect both private and public interests in the sense that it supports public policy for road safety; it can also be used by stakeholders having private interests either in relation to public issues or to protect their own goals and market. The scheme below aims at giving an overview of the various actors and stakeholders within both private and public interest spheres.

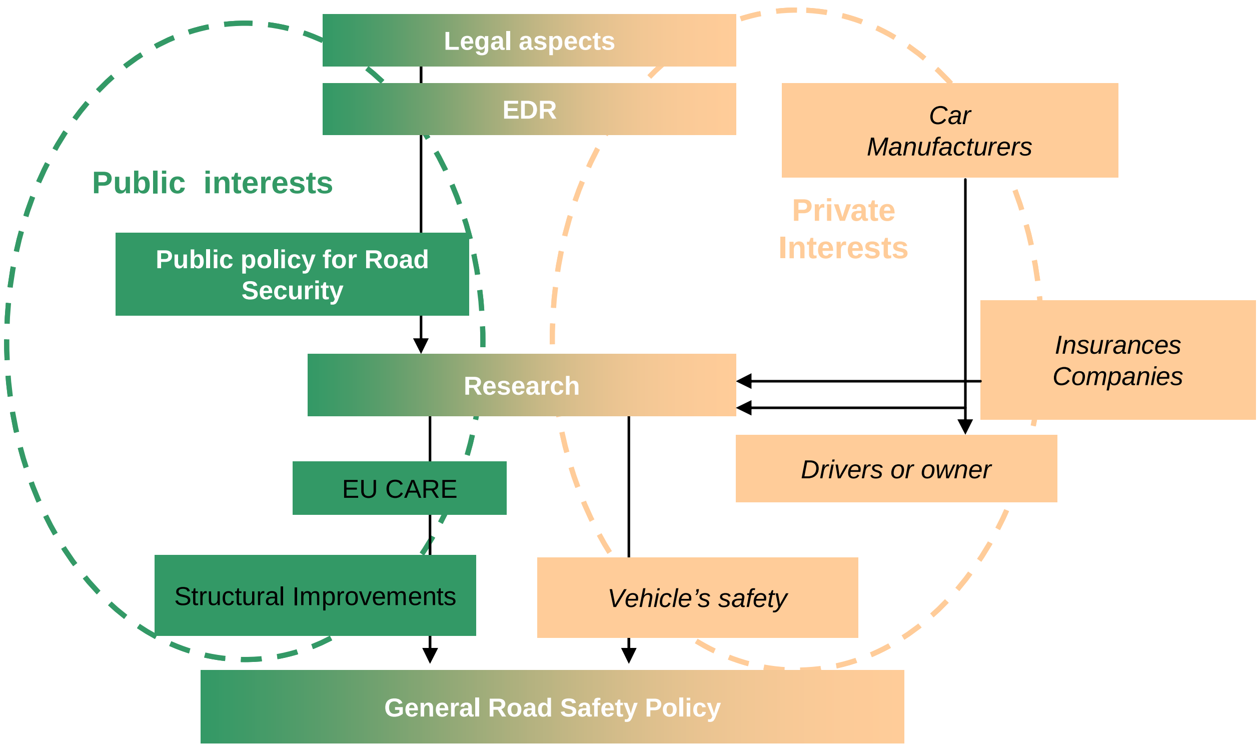

Fig. 22: Stakeholders and interests

6.1.2.3.3.4.1 Car manufacturers / Automotive Industry

1. Manufacturers can be interested in data for vehicle safety design research or for product liability purposes (see above). Considering that accident data are potentially personal, in the first case, prior consent from the holder and driver would be necessary. In the second case, manufacturers may not necessarily need any prior consent of the vehicle's owner although they would nevertheless have to handle the car's owner data in compliance with the data protection rules.

2. Dramatic car accidents can occur from malfunctioning of onboard units and/or vehicles' parts. Possible dysfunction of speed regulators, or, in static situations, such as the death of children locked up in vehicles have shown – if not demonstrate – that the vehicle manufacturer's liability can also be at stake. In such a case, car manufacturers have high interest in accessing EDR data that may offer evidence that would exonerate them.

6.1.2.3.3.4.2 Lease and Transport Companies

1. Since drivers and vehicle owners can be different, there is a need to address the case of vehicles rental as well as transport companies.

2. Rental vehicles companies have successfully installed EDR as a means to prove their innocence against the increasing use of their vehicles for deliberate and fraudulent accidents. The question whether property rights and crime fighting should supersede data protection in case of damage will usually be answered positively by the law. The Police have not only the right but also the obligation to investigate into crimes and can therefore apply all appropriate measures, including data download and analysis.

3. In relation to transport companies the use of EDR data is very likely to be linked to both insurance and legal issues. In such cases, EDR could be used either by the company in order to prove the responsibility of the vehicle manufacturer (and indirectly of its suppliers), or against the company in case the accident would have caused damages for which the driver, as an employee of the company, could be held responsible for.

6.1.2.3.3.4.3 Insurance Companies

1. Insurance companies may have contractual rights to request accident data from their clients; clients are obliged to cooperate as closely as possible with their insurers when it comes to the determination of their responsibilities. The issues related to data privacy should be made clear in the insurance contract since the driver must be informed whether or not the insurance company intends to use personal data to assess his responsibility if an accident occurs.

2. Voluntary ‘pay-as-you-drive’ schemes (extended EDR understanding) by contrast does not necessarily require to know who the driver was as the insurance premiums would be calculated on driving performance data of the insured vehicle. However, the French Data Protection Authority (CNIL) has recently stressed the need to balance means and objective, also putting forward that French insurance companies are not allowed to set up and manage files composed of offences committed by drivers.

6.1.2.3.3.4.4 Drivers

Drivers should benefit from all rights to access their data, regardless of whatever technical means or intermediary methods are used thereby granting them access rights.

6.1.2.3.3.4.5 Owners

Drivers and car owners can be different. Owners can require the access right to accident data to be exchanged or conceded when handing over the vehicle to the driver. As long as no accident occurs, no data exists. For example, rental car companies have successfully installed EDR as a means to prove their innocence against the increasing use of their vehicles for deliberate and fraudulent accidents. The question whether property rights and crime fighting should supersede data protection in case of damage will usually be answered positively by the law (see above).

6.1.2.3.3.4.6 Lawyers

The same principles as those applying to collision experts apply to lawyers. They have no autonomous right to take independent action but only when deferred to them by their clients.

6.1.2.3.3.4.7 Third Parties

1. Third parties, in particular victims when considered as plaintiffs, should be granted access rights by means of a court warrant or a court order. Dependent on national procedural law, the court would have to examine if the third party requesting data provides reasonable arguments that (s)he was involved in an accident with the vehicle in question and that this vehicle might contain data which could clarify causes and liability for the collision and the damage alleged.

2. In such cases, there should be no problem to granting access rights (in parallel with already established legitimate access) to written documents held by the defendant. A court warrant or decision would also be required if the data has already been downloaded by a public user (such as the Police). To confirm access rights to victims is particularly relevant for vulnerable road users (pedestrians, cyclists) who on one side represent a significant portion of road victims as shown under 6.1.1.2 and who on the other side cause less marks on the road and who are often subject to hit-

and-run behaviour by the drivers. Electronic marks recorded in an EDR would help all parties involved later on in explaining the causation also in such accident categories.

6.1.2.4 Storage and Tracking

6.1.2.4.1 Towards a traceability system?

1. Once EDR data has been extracted, the question remains to determine how it should be handled with regard to the threats aforementioned.

2. In addition to security measures that can be implemented to enhance security of data transfer, a rising issue concerns the interest of implementing a tracking system of extracted data. The fact that EDR data can also be used at EU level through the CARE database does not affect the interest of a data traceability system since data is made anonymous, and is therefore of no interest for any other purpose than research. The data traceability system issue must be set into perspective with the data handling issue so as to assess whether a decent storage system as regard to data privacy issue should be centralised or decentralised.

3. Although the value of implementing a data traceability system may be useful only under very few circumstances, i.e. major accidents causing severe damages or when an exceptional amount of money is at stake, this issue might become more relevant in the future, particularly if EDR effectively becomes mandatory, at least for certain categories of vehicles.

4. A system ensuring traceability of data within the ADF should not only aim at knowing where the data is, but also who is allowed to access EDR extracted data and who has effectively interacted with data. Considering that administrative data flow often varies depending on national legal frames, the design of a traceability system should be left to EU Member States. However, the system should be based on similar grounds within each Member State. For instance, security protocols used by Member States should be common to ensure the overall data security and identification of every data handler during data transfer or handling phases.

6.1.2.4.2 Centralised or decentralised approach?

1. Once data has been used, national legislation might require that it should be kept stored whilst remaining accessible with sufficient security conditions to avoid any later tampering. Data should be kept available until it is deleted. There is no EU law for this issue and the Directive 95/46, in its article 6, defers to law of EU Member States.

2. EAID experts have recommended giving priority to a decentralised way of keeping this data. The choice between a centralised or decentralised solution intrinsically depends upon the very administrative organisation of a Member State.

Depending on their respective administrative tradition and history, Member States may be tempted to favour a centralised or decentralised solution, i.e. a much centralised State is likely to go for centralised solutions and *vice versa*. This choice also strongly depends on the existing administrative data flow in a Member State in the sense that if existing structures make a decentralised/centralised solution easier to implement, the choice will depend on feasibility concerns.

3. In the end, the storage issue at national level should be left to Member States, which implies that storage will vary within the EU. However, if CARE is to be successfully implemented and used at EU level, there shall consequently be a centralised solution.

6.1.2.5 Overview of Administrative Data Flows within the EU

1. Part of the information detailed hereinafter result from the dissemination by WP2 leader of a questionnaire on accident database throughout March and April to EU Member States. The answers received cover only few countries and consequently further information has been identified by complementary means. This questionnaire was followed by a workshop focusing on accident database and host by BASt on 21st April 2008. The questionnaire consisted in the questions listed below:

1. What are the possible scenarios for the flow of information from the accident scene to the European CARE data base?
2. Are there regional and/or national statistical levels in your country?
3. Who coordinates the levels and prepares the data to be submitted to CARE?
4. What Hardware and Software security provisions are taken for data collecting and transmission?
5. Please, provide names and addresses of the institutions involved.
6. In addition to the traditional data bases (in terms of variables as used by CARE) in your country, are there any other in-depth databases (which investigate the causes of accidents)?
7. Who has access to the databases? Is certified qualification required?
8. What are the access security requirements?
9. When is accident data transmitted to the databases (with respect to the time of the accident or legal requirements)?
10. Understanding what data EDR would provide: How would one define the variables for an in-depth database?
11. Would the EDR data download (by private or public accident reconstruction experts) have to be prepared in a particular way for a structured feed into databases, or is it more reasonable to have this done

by a national institution for data coordination?
12. What would be the most appropriate and easiest way to combine EDR data with other important accident data taken from the police reports?
13. How is accident data anonymised for statistical purposes in your country?
14. Which do you regard as the most appropriate body for an in-depth database in your country?

Fig. 23: Questionnaire

2. Hereinafter, "basic data" refers to "*anonymous accident data elements used mainly for monitoring trends and priority identification*"[28]. This kind of data is used, for instance, to populate the EU CARE database, with EDR data. This section presents the ADF for basic data collected in Sweden, Finland, the UK, France and Netherlands. These countries are all contributors to the CARE database.

6.1.2.5.1 Sweden

1. The existing administrative data flow relating to car-accidents in Sweden has to be put into perspective with the existing "Zero Vision Policy" developed by Sweden for more than a decade, which involves all direct and indirect actors of the road transport traffic sector (car manufacturers, public authorities, etc.) and sets the in-depth analysis of all car-accidents as a rule.

2. The data collection process runs under the authority of the Ministry of Industry, Employment and Communications, via the Swedish Road Administration (SRA), which acts as the overall coordinator and centralising body for any data collection process related to road accidents. It is worth noting that the competences belonging to SRA in that respect will be transferred to the Swedish Transport Agency, officially set up on 1st of January 2009. As such, the SRA runs a central database in which police and hospitals upload collected data. At this stage, it shall be pointed out that hospitals provide detailed reports of injuries.

There can be potential data-privacy issues depending on the content and the administrative data-flow of hospital reports if this data was to be merged with EDR data.

[28] This definition is proposed by the RO-SAT Working Group

3. There is, however, a distinguishing difference in the way data is processed depending upon whether it is related to fatal accidents or not. Whereas average accident data is processed by regional police offices and hospitals, all data related to fatal accidents is processed by regional offices of the Swedish Road Administration. Each year, about 17,000 accidents and 450 fatal accidents resulting in personal injuries are analysed. Besides the basic level of data investigation, there are three levels of in-depth studies in Sweden:

- The Swedish Accident Investigation Board (SAIB) is an independent organisation dealing with fatal accidents involving more than 5 victims;
- The Systematic Collaboration for Safer Road Traffic (OLA), is a new working approach introduced at the SRA in 2002 to enhance accident prevention;
- The Regional Road Administration offices lead in-depth studies of all fatal accidents.

4. Information about road traffic accidents is collected by the Police and hospitals, which both use software to populate the STRADA (Swedish Traffic Accident Data Acquisition) database with relevant data. The STRADA information system is a coordinated national registration of traffic accidents and traffic injuries. It is run by the police and the health care authorities and concerns the whole road transport system. Organisations such as the Police, the National Federation of County Councils, the National Board of Health and Welfare, the Swedish Association of Local Authorities, the Swedish Institute for Transport and Communications Analysis (SIKA), and Statistics Sweden (SCB), co-operate with the Swedish Road Administration.

5. Since 2003 the police report data covers the entire country and currently half of all hospitals with emergency units contribute to STRADA. The objectives of STRADA are to support the traffic safety work on national, regional and local levels, to provide facts for decision-making regarding more accurate safety measures, and to make public administration more efficient. The data collected by the police includes information about when, how and where the accident took place, traffic environment, speed limit, the circumstances of the accident, light and road surface conditions, passive safety systems used, and some detailed facts about the injured persons[29].

6. For electronic exchange of information, the security of transferred information is ensured by the use of a Secure Socket Layer, a protocol enabling a secure connection between the source and STRADA. The information is coded during the transmission.

7. Following the method set up by the “Zero Vision Policy”, most – if not all- the actors involved in road safety issues can access the STRADA database. This implies a wide potential scope and range of actors. To get access to STRADA, a secrecy document is signed and backed-up by a log-in procedure. Data is then accessible via a web-site where it can be downloaded either in Access or Excel format.

[29] Report 2007 on CASE – Centre for Ageing and Supportive Environments : http://www.med.lu.se/case

8. This central database is also used to populate the CARE database at EU level. However, STRADA data is not directly exported to CARE. It is delivered by Statistics Sweden (Ministry of Finance) in charge of preparing and delivering the data on behalf of SIKA (Ministry of Enterprise, Energy and Communications).

9. The “Zero vision policy” plays an important role in the administrative data flow since its rationale is that all transport and road traffic actors should work together to improve road safety. As a consequence, accident data can be accessed by several different organisations. However, it was made clear by the CORTE membership that EDR data is currently not used to investigate accidents.

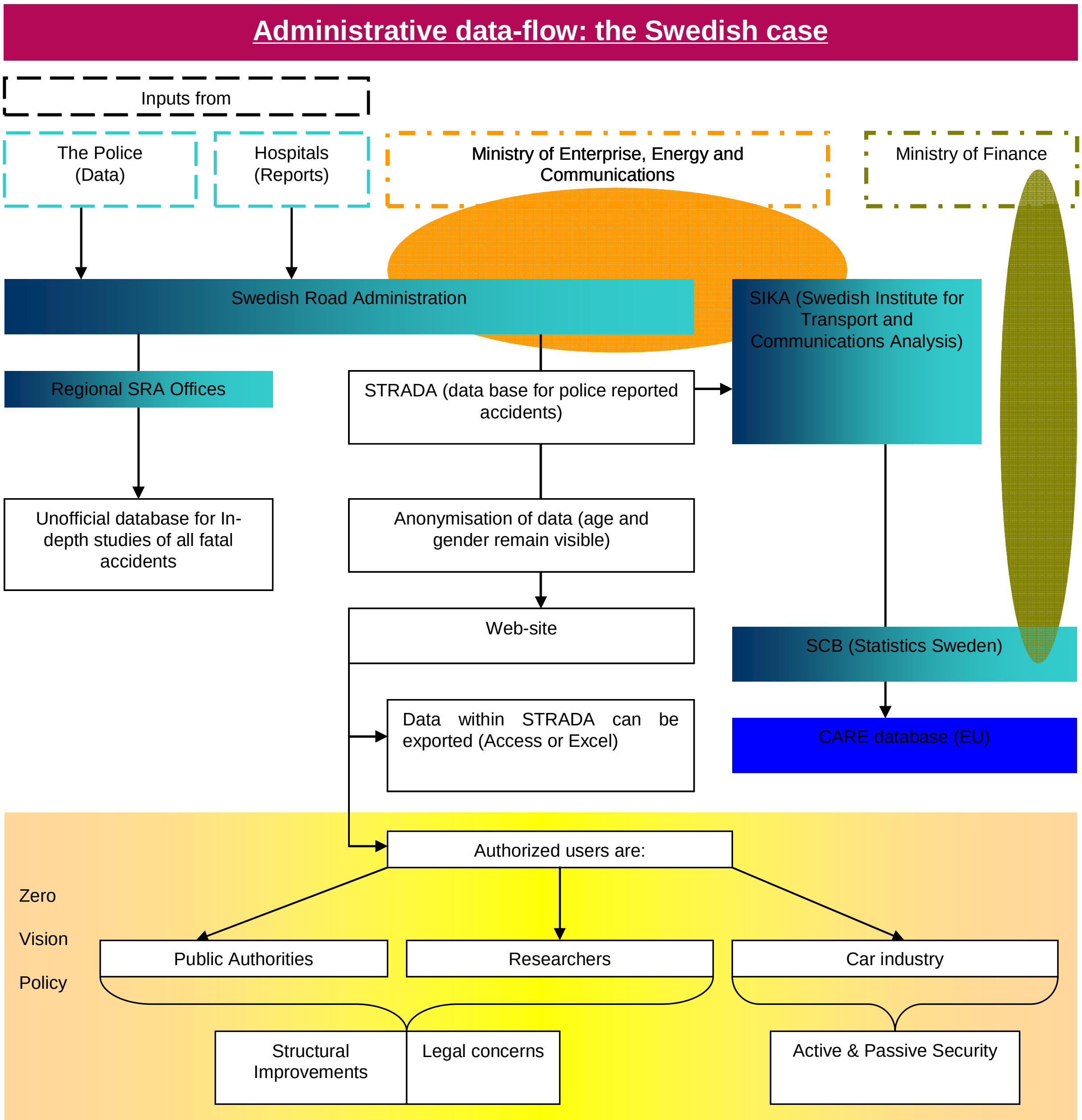

Fig. 24: Data flow within Swedish case

6.1.2.5.2 Finland

1. The road accident data collection in Finland is quite multi-layered, however not as much as it is the UK (see hereafter).

2. Basic data collection for all kind of accidents is conducted by the police, Statistics Finland, the Road Administration and insurance companies. However, the field work is largely undertaken by police investigators. The multiple layers structure and management of data collection implies 4 different Ministries:

Ministry of Interior;

Ministry of Finance;

Ministry of Transport and Communications;

Ministry of Social Affairs and Health.

3. Road accident investigation is steered and supervised by the Road Accident Investigation Delegation set up by the Ministry of Transport and Communications and maintained by the Finnish Motor Insurers' Centre (VALT) -a joint organisation for motor insurance companies established in Finland- mainly through its Traffic Safety Committee of Insurance Companies. Insurance companies have a very important role both in data analysis and handling processes.

4. *Statistics Finland:* Road accident statistics are used to evaluate the level of road safety at both national and international levels, leading to collaboration between Statistics Sweden and Norway. Statistics Finland receives data on road traffic accidents from the police, which is then entered into the PATJA information system, and serves as the main source for the collation of statistics. The PATJA information system, intended for national use, is a register of individuals maintained by means of an automatic data processing system. The data content of the system is extensively regulated by law. All criminal offences, as well as violations, are recorded into PATJA. When an offence is reported to the police (or becomes otherwise known to the police) the police register the case into a reporting system scheme from where the data is automatically copied into an operational database. Thus, there are two databases: the reporting base and the operational base[30].

5. The database is mainly used at national level by Ministries, central agencies and transport organisations. The main users at the local level are municipalities. Monthly statistics are available for public consultation in electronic form on the website of Liikenneturva (the Central Organization for Traffic Safety in Finland).

[30] Perspectives on crime statistics in Finland http://www.tilastokeskus.fi/sienagroup2005/lattila.pdf

6. *Finnish Road Administration:* The Finnish Road Administration receives the data on road traffic accidents from the police which is then entered into the PATJA information system of police affairs. The Finnish Road Administration is responsible for the maintenance of the database. The main users of these statistics are researchers and traffic engineers in Finnish Road Administration's central office as well as in regional offices. Other users are Ministries as well as various central agencies and transport organisations. Data is used for road safety research, safety audition, black spot management and calculation of accident risks.

7. *VALT: Database on fatal road traffic accidents:* The objective is to produce information and safety suggestions to improve road safety through studying road and 'off-road' traffic accidents. In practice, files are collected in the field investigation and they are available to the traffic safety work as laid down in the data protection legislation. According to the Road Accident Investigation Act and its preamble, accident investigations serve to strengthen the information made available for road safety purposes. The data obtained in road accident investigations is only used to ultimately increase safety.

8. Finland has also set-up the Accident Investigation Board, under the authority of the Ministry of Justice for multi-modal investigations, or for major road accidents. In such situations, accident investigators work in cooperation with the police.

9. The Finnish ADF is characterised both by the high number of ministries involved directly or indirectly in the data collection and handling process, and also by the major role played by insurance companies who are a major component in the road safety public policy. In addition, Scandinavian countries (including Norway) use a similar organisation to handle statistics through an *ad hoc* structure (Statistics Sweden/Finland/Norway). Finland also contributes to the CARE database.

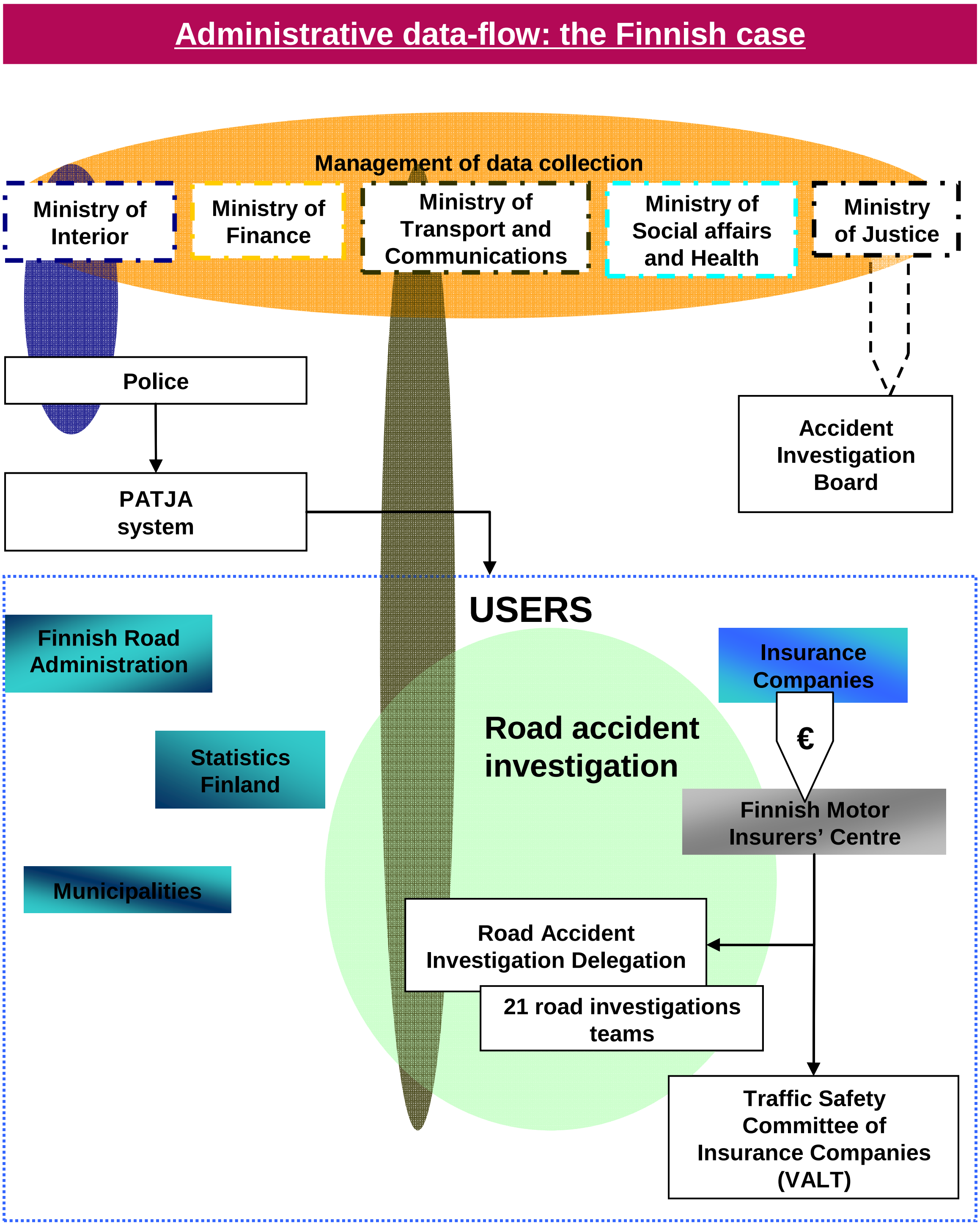

Fig. 25: Data flow within Finnish case

6.1.2.5.3 United Kingdom

1. The Administrative Data Flow in the United-Kingdom is characterised by a multi-layered data collection system, which aims at enhancing in-depth studies of car-accidents, notably by getting as close as possible to the initial conditions in which accidents occurred.

2. Although basic statistical details are still collected in situ by the police officers, several other programmes or entities are involved in the overall UK Administrative Data Flow, most of them working under the authority of the Department for Transport.

3. As far as the EDR is concerned when it comes to accident investigations, the focus for UK Administrative Data Flow should be set onto 3 main channels of data collection, namely:

- Stats19;
- All Fatal Crash Investigations;
- On Spot Accident Data Collection (project).

4. The focus is set onto these three channels because data is collected *in situ* by police forces as quickly as possible after the crash occurred. EDR data can consequently be considered as inputs that potentially meet the needs of actors involved in any of these programmes, and should consequently be considered as useful in their respective administrative data flow.

5. STATS19 is the primary source of data used to monitor the number of road accident casualties and progress compared to policy targets. STATS19 consists of data collected following a national standard by local police forces and local authorities. STATS19 forms the basis for comparing UK statistics with road accident statistics reported by other nations. The police collect data for all fatal crash investigations, and also to populate the Stats19 file serving as the core UK file for basic statistical level. Whereas Stats19 is set under the authority of the Department for Transport, data related to fatal accidents are collected by specialist Police Officers belonging to local police forces in the UK. In any case, this data can be used in the judicial process or for research analysis.

6. Concerning the Police Fatal Crash Investigation, the UK system is also specific in that investigations are conducted by specialist crash investigators who treat each fatal accident as a crime. Consequently, investigation process is independent and used for judicial purposes. All copies of investigated files are gathered and indexed in a central location.

7. For research purposes, data can be collected either by Police officers and/or specialist investigators and is made anonymous. Research activities are mainly conducted by the TRL (Transport Research Laboratory) as a subcontractor of Department for Transport and results are used to inform regulatory activities in road and vehicle safety area.

8. A specific project called “On the Spot Accident data Collection Study» was developed in the UK to optimise accident analysis by collecting relevant data as soon as possible so as to limit the retrospective dimension of analysis and to take into consideration ’volatile’ data.

9. In the end, if EDR was to be made mandatory, EDR data would very likely be used as additional input to go deeper into the analysis. In the ‘On the Spot Accident Data Collection Study’ project, data is collected *in situ* by crash investigators either by TRL or the VSRC (Vehicle Safety Research Centre – Loughborough University).

10. The UK approach to road accident data collection and investigation is characterised by widespread cooperation between several bodies and programmes. National authorities, as well as local authorities and several universities and research centres, can intervene. The system is consequently much decentralised, thus potentially impacting the data handling issue. The UK is a contributor to the CARE database.

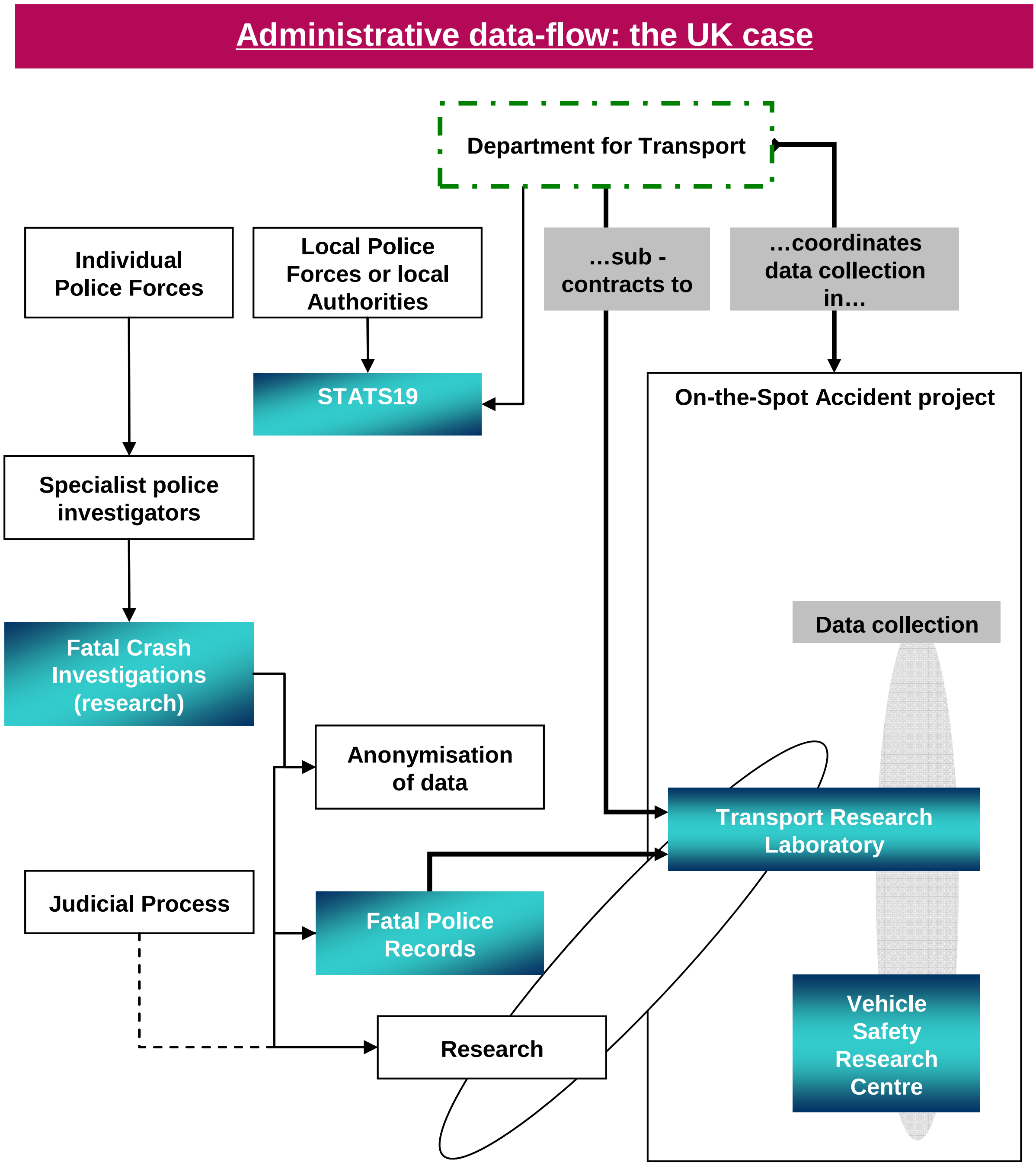

Fig. 26: Data flow within UK case

6.1.2.5.4 France

1. The data collection process in France is placed (at least for basic data) under the control of the Ministry of Ecology, Energy, Sustainable Development and Land Planning via the Observatory of road safety.

2 *In-situ* collection of data can be either conducted by Urban Police, Gendarmerie or Republican Company of Security (CRS), depending upon the location of the crash. Data in France is mainly collected to determine judicial responsibilities, more than to further investigate the reasons behind the crash. This would tend to lend to EDR data a particular relevance when the ADF is used in court and legal issues.

3. The French national road accident data is based on the BAAC (*Bulletin d'analyses des Accidents Corporels de la Circulation*), which is an electronic standard form. Once the BAAC form is filled, it is sent to the National Interministerial Road Safety Observatory (ONISR), either by the Gendarmerie, the Police or the CRS to be manipulated and further checked by the SETRA (Technical Department for Transport, Roads and Bridges Engineering and Road Safety of the French ministry of Ecology, Energy, Sustainable Development and Town and Country Planning). The SETRA hosts and maintains the database on behalf of ONISR, while the latter controls the access to the data.

4. However, data also serves research and structural improvements. For this purpose, collected data is used by satellite-service of the Ministry such as the CETE (Centre d'Etudes Techniques de l'Equipement), a public engineering service dealing with, amongst others, road safety. Outside the Ministry, other research-oriented organisations might use EDR data, notably the INRETS (the French National Institute for Transport and Safety Research), the ASFA (The Federation of French Motorway and Toll Facility Companies), the LAB (the Laboratory of Accidentology, Biomechanics and the Study of Human Behaviour) and the CEESAR (European centre for safety studies and risk analysis).

5. The ADF is similar to the UK in the sense that it is multi-layered. However, the overall research activity based on road statistics/data is more homogeneous in the sense that it does not involve as many agencies as in the UK. Public authorities remain the main contributors to road safety. As such, the French model does not rely upon cross-partnerships as it can be the case in Scandinavian countries and in the UK. France contributes to the EU CARE database.

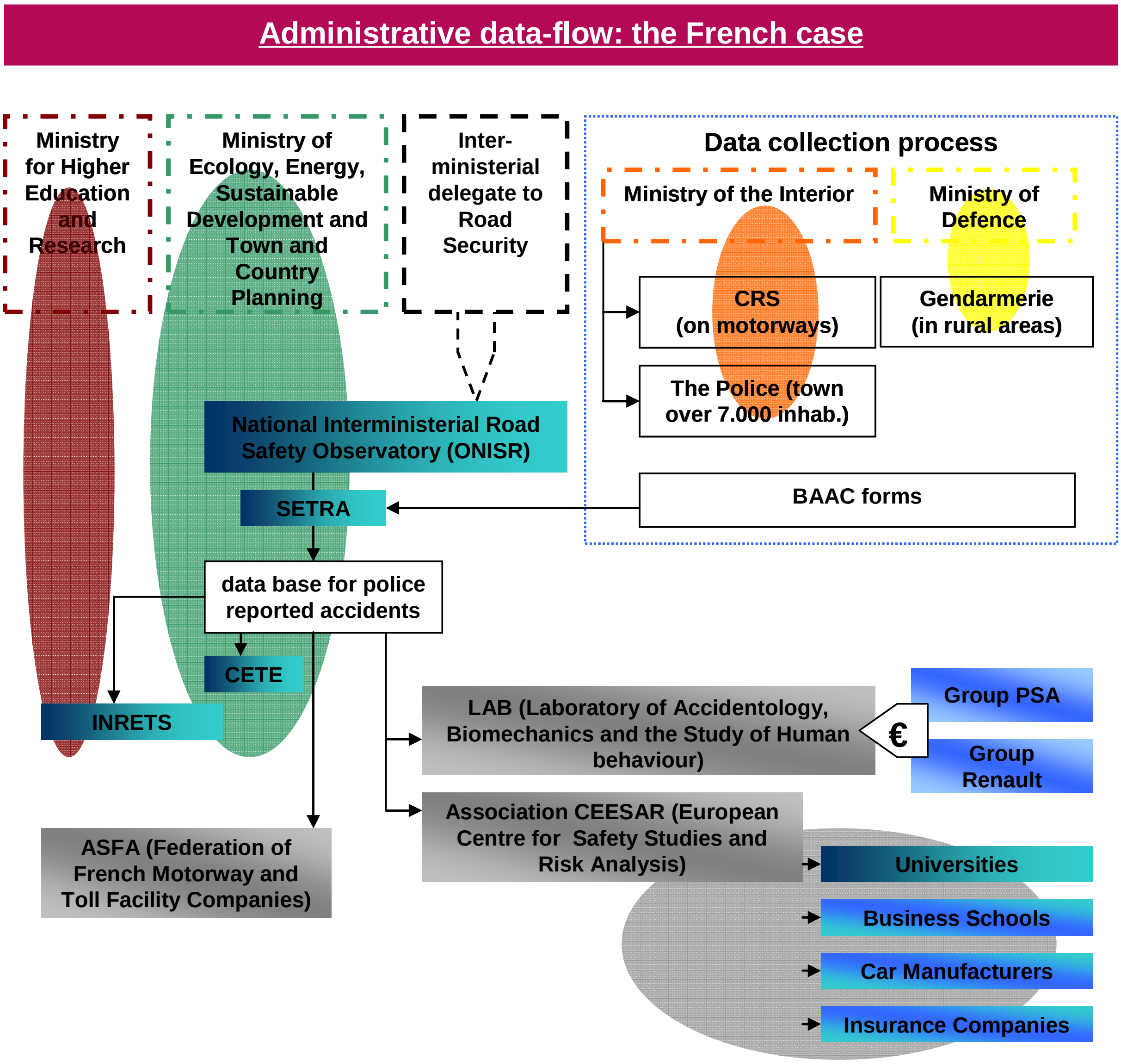

Fig. 27: Data flow within French case

6.1.2.5.5 The Netherlands

1. The case of the Administrative data flow in the Netherlands is of particular relevance as far as EDR data is concerned since the Dutch police has the legal obligation to use all available data, including than EDR data whenever applicable.

2. The ADF of basic data in the Netherlands starts with the police collecting accident related elements. Collected data is printed and transferred by ordinary mails to competent offices of the Centre for Transport and Navigation, placed under the authority of the Ministry of Transport. From there data is processed according to national standards and supplied as annual statistics to CARE and other possible interested parties.

3. There are no particular actions implemented to enhance security, confidentiality and integrity of data during the transmission from an organisation to another. However, Dutch authorities have planned to implement in the near future a digital channel to ensure transmission of data with encryption systems. The content of the accident database is public but digital access is restricted.

4. However, according to the Dutch Ministry of Transport, the combination of EDR data with other accident data could be done through the development of a publicly accessible database containing EDR data along with “sufficient linking keys”, such as VRN (Vehicle Registration Number), VIN (Vehicle Identification Number), etc. Considering that the VIN only requires little additional investigation to lead to the identification of the vehicle’s owner and/or driver, and also considering the EAID statement that EDR data is personal, such a proceeding should be put into perspective with data privacy issues.

5. The case is similar to Sweden in terms of data availability. It was clearly stated by the Dutch Ministry of Transport that EDR data should be made available to any potential road safety stakeholders, either for enforcement or research activities.

6.1.2.6 Conclusions

1. The need of EDR data as "real-life-in-depth-data" for road safety research purposes as well as for judicial applications in accident reconstruction is pre-eminent and undisputed and justifies the mandatory implementation of EDRs.

2. We wish to put forward that what is referred to as the Administrative Data Flow (ADF) in this document consists, as a matter of fact, of two ADFs. One from the accident site to legal bodies for individual accident investigation and its legal consequences and the other to the research institutes. However the structure of the ADF varies from one country to another.

3. Accordingly, even if Member States have developed their own ADF based upon their national legal framework related to data privacy issues and enforcement, they have a lot in common. It is all the more accurate when it comes to data occupancies since public policies for road safety are mainly developed on similar models, i.e. complementary actions of public or private research bodies and enforcement authorities.

4. The different existing ways to use EDR data at national level and the multiplicity of actors and agencies involved in national ADFs and the opportunity to set up a traceability system to improve control of the overall data handling aspects should be put into perspective with the possible development at EU level of a common data security protocol, at least for what concerns data transfer from a body to another, be it at national or EU level as it is required for feeding the CARE database.

5. The question to determine is whether or not a centralised approach is more relevant and efficient than a decentralised approach should be left to the EU Member States. However, at EU level the development and implementation of the CARE database should be strictly designed on a centralised approach, which implies a common final stage of Administrative Data Flow for CARE participating Member States.

6.1.3 Data privacy issues

6.1.3.1 Introduction

1. Developments in matters of public policy on road safety at the Community level stem from the publication in 2001 of the European Commission White Paper - DG Energy and Transport (DG TREN) - which defines the framework for public action seeking to reduce by half the number of victims of road accidents by 2010.

2. Different means are emphasised in the White Paper to assist Member States meet this EU target, including the proposal to use Event Data Recorders (EDR) to allow the public and private stakeholders to better understand the circumstances in which an accident occurred, while allowing public authorities to accelerate and improve court decision-making, when necessary.

3. Although a full presentation of an EDR is available *via* the D2-04 "*Data Use outside the Vehicle*," it is necessary to clarify that, although EDRs can help to strengthen public policies for road safety, they do not intrinsically constitute safety tools. The purpose of an EDR is to gather information on a vehicle's condition when an accident has occurred. It therefore concerns post-analysis more than prevention. However, various studies have shown that the presence of an EDR in a vehicle can reduce the likelihood that an accident will occur and its severity by about 20%.[31] The driver, knowing that there is retroactive monitoring of his conduct, adapts his behaviour on the road so as not to be held liable in an accident, and thus to avoid bearing the legal penalties or fines that might result.

4. EDR data allows an understanding of the circumstances of a road traffic accident, i.e. which vehicle contributed how, allowing some conclusions on the drivers' actions. Combined with measures to identify the drivers, information which is obtained from other sources and not from the EDR, its data ultimately helps establish who bears the liability for the accident. In addition, EDR data can also be used to serve research in matters of road safety. Thus, data from an EDR can be used by various stakeholders, whether public or private, involved in road safety. The entire process during which the EDR data is used, in one way or another, until it is archived or destroyed, is the *Administrative Data Flow* (ADF), described in D2-04.

5. The data that can be recorded by an EDR has been defined within the framework of the VERONICA projects. This data is useful to give an accurate picture of the vehicle's status and performance during the 45 seconds covered by the EDR. Since the objective of an EDR is specifically not to obtain a "*transparent driver,*" the EDR data does not address the driver's identity. However, the entire Administrative Data Flow and the various options for use and management of EDR data raise some issues on the trustworthiness of this data, and present a number of issues with regards the rules governing its protection.

6. Community law in effect regulates the protection of personal data by means of Directive 95/46/EC, which constitutes the reference text on the subject, and whose objective is to guarantee the necessary balance between a high level of privacy and the free flow of personal data within the EU, needed to strengthen scientific and technical cooperation as well as proper cooperation between Member States.

7. This document is complementary to the D2-04 on Administrative Data Flow. It aims to give the reader an overview as comprehensive as possible of the various issues relating to the processing of data extracted from the EDR within the legal framework of the protection of personal data and, *in fine*, to recommend an operating procedure concerning data processing.

7. This deliverable follows the technical specifications of the EDR which were elaborated in the VERONICA I project and subsequently specified in detail in the present project, including the level of data security. Therefore, the purpose of this document, considering the technical constraints which were seen as necessary to be set for the EDR, is to determine to what extent EDRs could be introduced in certain categories of vehicles without being in conflict with data protection rules.

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[31] European Commission (2005). *Cost-benefit Assessment and the Prioritising of Vehicle Safety Technologies*. European Commission Directorate General Energy and Transport: Final Report

6.1.3.2 Principles for data privacy

6.1.3.2.1 Directive 95/46/EC

1. The Directive governs the protection of personal data through the prism of the free exchange of data, in accordance with the fundamental nature of the movement of data between Member States in order to ensure proper cooperation between them, while providing a legal framework protecting personal data.

2. The Directive applies to data processed by automated means, including the data contained or required to appear in non-automated means. It is a philosophy linking protection of fundamental rights and freedoms in the digital environment with free movement of data within the EU, while posing as a postulate that the digital environment should not affect civil liberties or the private space. Accordingly, the techniques should be implemented only on the condition *sine qua non* that they respect fundamental freedoms and human dignity.

3. Directive 95/46/EC identifies two major areas where Member States shall ensure the protection of the fundamental rights and freedoms of individuals, including their right to privacy with regards to the processing of personal data, or according to their inability to restrict or prohibit free movement of personal data between them. The compromise in the Directive combines these two obligations, without either reducing the strength of the other.

4. Essential elements of the Administrative Data Flow, the players in charge of processing or routing of data are defined as follows in Directive 95/46/EC:

5. The processing manager: the physical or legal entity, public authority, department or any other agency, which alone, or jointly with others, determines the purposes and methods of processing personal data; where the purpose and means of processing are determined by national laws or regulations or community, the processing manager or the specific criteria for his appointment may be established by national or Community law;

6. Sub-contracting: the physical or legal entity, public authority, department or any other agency, which processes personal data on behalf of the processing manager;

7. Third parties: the physical or legal entity, public authority, department or any other agency, which processes personal data on behalf of the processing manager.

8. The activities of stakeholders involved in any of the different phases of processing is also regulated by Article 6 of Directive 95/46/EC, which states that processing for historical, statistical or scientific purposes is not considered incompatible with the protection of personal data, when appropriate safeguards are provided by the Member States. In addition to Article 6, Article 7 provides that Member States can process personal data on condition that the person concerned has indisputably given his consent, or if the processing of such data fulfils:

9. The execution of a contract to which the person concerned is a party;

10. A legal obligation to which the processing manager is subject;

11. The execution of a mission that is of public interest (...)?? or within the exercise of official authority vested in the processing manager or the third party to whom the data is disclosed;

12. The service of the legitimate interest pursued by the processing manager or by the third party or parties to whom the data is disclosed, on condition that the interests or fundamental rights and freedoms of the individual do not prevail (...)??.

6.1.3.2.2 Definition of personal data

1. According to the terms of Directive 95/46/EC, personal data is information regarding an identified or identifiable physical entity (individual concerned); a person is considered to be identifiable when he/she can be identified directly or indirectly by reference to an identification number or to one or more specific factors related to his physical, physiological, psychological, economic, cultural or social identity.

2. In other words, data that is not inherently personal might become personal as of when, through a cascade effect and depending on the effort to be taken to link the data to an identifiable person and depending on in which hands the data are, it can be linked to an individual and has a non-negligible impact on individual suffering. Thus, data considered impersonal must have this status confirmed when its entire environment and the likelihood of efforts for identifying a person are taken into account and analysed.

3. The Directive states that the principle of data protection does not apply to data rendered anonymous so that the person to whom such data refers is no longer identifiable; this is not therefore relative anonymity but absolute anonymity.

4. What at first sight appears easy to decide causes problems in practical life. Data protection experts are being confronted with the need to provide interpretations to the directive. The Article 29 Working Party, an advisory committee composed of representatives of the national supervisory authorities from EU member states as well as for example the UK Information Commissioner's Office (ICO) have become repeatedly engaged in providing guidance papers, in particular on the question what is personal data and what is not. Their guidance aims at helping *"practitioners decide whether data falls within the definition of personal data in circumstances where this is not obvious"*.[32]

6.1.3.2.3 The basic principles of protection of personal data

Several guiding principles determine the lawfulness of the processing in the context of Directive 95/46/EC. These principles apply to any information concerning an identified or identifiable person.

[32] ICO Paper *"Data Protection Technical Guidance Determining what is personal data"*, p. 1, http://www.ico.gov.uk/upload/documents/library/data_protection/detailed_specialist_guides/personal_data_flowchart_v1_with_preface001.pdf, quoted ICO, p

6.1.3.2.3.1 The right to anonymity

1. Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector – important elements of the transmission of EDR data in the ADF – as a guiding principle imposes the objective of keeping the "processing of personal data and the use of anonymous or pseudonymous data to a minimum where possible."

2. Although anonymity is a principle with constitutional value in some countries, it is necessary to distinguish absolute anonymity from relative anonymity. Absolute anonymity must be assessed with regards to the three phases that characterise the life of the data, namely:

- Collection;
- Processing;
- Retention or storage.

3. Data that displays the characteristics of relative anonymity can be defined as data for which a simple reading, or use, does not establish any link whatsoever to a given person. However, crosschecking the data with additional data can make this data go from being of an anonymous nature to being personal data. But *"the fact that there is a very slight hypothetical possibility that someone might be able to reconstruct the data in such a way that the data subject is identified is not sufficient to make the individual identifiable for the purposes of the Directive"*[33]. Thus, the characterisation of non-personal, negligible impact on individual suffering or relative anonymity is linked to the effort that must be provided in order for the data to be considered personal.

4. The technological protection of [private]?? life covers a range of methods to ensure the protection of privacy, without impacting the necessary use of data in the context, for example, of public policies for road safety and research and development phases in order to improve the safety of infrastructure or vehicles.

Among these various methods, the process of making data anonymous results from the necessity of retaining data beyond the period that justified the collection and processing, or the need for analysis, of the sensitive information.

6.1.3.2.3.2 The principles of purpose and proportionality

1. The principle of purpose is at the heart of many regulations concerning the protection of personal data, regardless of its form.

2. The purpose is a characteristic of the relationship between the data and its processing. It allows the range of uses to be limited in order to reduce the risk of fraudulent use, or its simple diversion for use, for other than the original purpose. Thus, automatic or manual processing can only bear on data collected for purposes that are specified, explicit and legitimate. Data cannot be used subsequently for purposes contrary to the original purpose.

[33] ICO, p 7

3. Proportionality is a general principle of law, and in this case it must be evaluated with regards to the vocation of the data. As regards the protection of personal data, the purpose is to ensure a balance between the prerogatives of those responsible for the processing and the rights of the persons concerned.

4. Proportionality stems from the fact that personal data must not be excessive in relation to the purposes for which it is collected and any further processing it is subjected to. In addition, the interest for which such data is collected must be legitimate and must not to interfere with the interests or fundamental rights and freedoms of the persons concerned.

6.1.3.2.3.3 The right to transparency

This principle implies that the persons concerned by the data considered “personal” should be able to exercise control over personal information concerning them, be informed of their rights, express prior consent, limit its use to purposes that are proportionate and legitimate and to know all the information relating to them that is held by all persons acting on his data.

6.1.3.2.3.4 The right to omission

The voluntary omission of data consists of requiring processing managers not to retain personal data beyond the original purpose.

6.1.3.2.3.5 The right to security

1. With regard to the protection of personal data, the concept of security, or at least its legal requirements, covers its integrity and confidentiality. To preserve data integrity, the processing manager must be careful to maintain the physical and logical integrity of the data being processed. It is up to Member States to identify and implement all the technical and organisational measures to protect personal data against destruction, loss, alteration, disclosure or unauthorised access, especially where the processing involves the transmission of data over a network, and against any other unlawful form of processing. These measures, implemented by Member States and defined by them in terms of the feasibility and cost of implementation, are designed to ensure an appropriate level of security with regards to the processing risks and the nature of the data to be protected.

2. In France, for example, the CNIL (Commission Nationale de l'Informatique et des Libertés) [National Commission for Data Protection and Freedom Rights] makes the distinction between voluntary and accidental breaches of security. The latter are those that result from equipment failures or from sources that ensure the operation of IT systems such as power supply, etc. whereas voluntary breaches affect the total or partial destruction of facilities, as a result of theft, tampering with software, and misuse or destruction of information.

3. Furthermore, in order to guarantee confidentiality during the Administrative Data Flow, the recipients of the data and authorised third parties must be identified, as well as the scope of their jurisdiction, and therefore the use that is to be made of the data. Moreover, any person acting under the authority of the processing manager

or the subcontractor, including the subcontractor himself, who has access to personal data, cannot process it except on instructions from the processing manager, except pursuant to legal obligations.

6.1.3.2.4 Lawfulness of processing

The lawfulness of the processing of personal data is largely governed according to the terms of Directive 95/46/EC based on the consent given by the person concerned by the data, de facto authorising the withdrawal and processing of personal data. Consent must have been given in such a manner that its factual reality cannot be in doubt. As concerns the contractual relationship, when the contract covers the relationship between parties and specifies the purpose of the recording and processing that the data may undergo, the consent may be deemed acquired beyond a doubt. Consent is not, however and this is relevant when we talk about mandatory EDR implementation, deemed mandatory if the context for the sampling and processing of data fulfils one of the situations defined in Article 7 of Directive 95/46/EC, as described above under point 13.

6.1.3.3 The Use of EDR Data with regards to Directive 95/46/EC

6.1.3.3.1 Data stored in an EDR

An EDR permanently records information in form of digital data related to the vehicle’s status and driving performance. When the driving performance crosses a safety threshold, predefined by several variables, and materialises into crash, then the data in the EDR is frozen in order to be used thereafter for investigation purposes. The data thus frozen covers a fixed period of approx. 45 seconds, divided into 30 seconds before the accident and 15 seconds afterwards with no data recorded on normal driving behaviour. Neither is there continuous data on location recorded nor is data transmitted (with the exception of the post impact position and the crash severity if the trigger is also used for e-call applications). Accident data covers only a time lapse of less than a minute which makes them uninteresting in establishing a driver profile. After two accident-events the first one will be automatically deleted if they have not already been deleted subsequent to a professional download procedure. The table below shows the data to be recorded in an EDR:

No	Recorded information	Explanation
1	Collision Speed	Speed at moment of impact
2	Initial Speed	Speed at start of recording a/o braking
3	Speed Profile	Pre- and Post crash
4	Change in velocity due to a collision	Δv = Delta-v = Change in velocity due to a collision
5	Longitudinal acceleration (IP)	Impact phase (high resolution)
6	Transverse acceleration (IP)	Impact phase (high resolution)
7	Longitudinal acceleration	Pre- and Post crash (low resolution)
8	Transverse acceleration	Pre- and Post crash (low resolution)
9	Yawing	Pre-crash yawing
10	Tracking	Displacement tracking of collision sequence.
11	Position	Absolute post impact position
12	Status Signals	Brake light, indicator, lights, blue light, horn...
13	Trigger Date and Time	Convertible into real time after download
14	User Action	Throttle, brakes, steering, horn, clutch...
15	Monitoring Restraint Systems	Airbags, Seat Belts
16	Monitoring Active Safety Devices' actions	Active Safety Devices (ESP, brake assistant, ABS) go/no-go self-diagnosis for purposes of exoneration of the manufacturer
17	Monitoring displayed Active Safety Devices' error messages	Messages on faults of ABS Systems etc. for purposes of exoneration of the manufacturer
18	VIN/VRD	Vehicle Identification No./Vehicle Registration No.
19	Driver-ID	Key, Smart Card, Code ...
20	Monitoring Driver	Visual Monitoring

General agreement for enforcement, insurance and rescue purposes

Secondary importance

Useful only for specific purposes

Fig. 28: Agreed data elements and their importance

The data thus frozen in the EDR is to be analysed, either as part of the research activities of a road safety research institution, or as part of a legal investigation into the circumstances of the accident. In both cases data is required that is absolutely related to the vehicle(s) involved in the accident and not directly related to the driver(s) involved.

6.1.3.3.2 Security level related to access EDR Data

1 The issue of the level of security required to protect EDR data from various already identified threats has been addressed in the deliverable D3-05. In this part, the authors speak in particular about:

- the EDR's security architecture;
- as well as access to the EDR, and thus to the EDR data.

2. The EDR's security architecture should be simple, or at least, not be excessive in relation to the purpose of the EDR data and the risks of manipulation, which are themselves to be assessed according to the criteria of feasibility.

3. Given that a complex security system introduces new variables and unknowns, thus potentially putting at risk the protection of data and the operation of the EDR, the EDR's security architecture should be basic in accordance with the technical recommendations given in this project[34] the D3-05. However, this situation implies *a minima* that the security architecture surrounding the EDR solely consists of the "junked carcass" that the vehicle represents, which alone is not a full guarantee of security sufficient to ensure the protection of the data in the on-board systems in general and in the EDR in particular.

4. The evidence shows that access to EDR data requires as a first step access to the vehicle. Based on this finding, only the drivers or owners of the vehicle can theoretically access it. Access to the EDR is theoretically also possible when the vehicle is left in a garage. In such cases, only accredited garages would *a priori* be legally authorised and equipped to access the EDR for the sole purpose of extracting or analysing the data without affecting its integrity. But to effectively access EDR data it needs considerably more than just opening a car's door. Further requisites are:

- Download device (laptop computer)
- Download software
- Transmission interface
- Device Driver
- Vehicle knowledge to find the interface in which to plug in (location will be different from vehicle to vehicle)
- Training for the application of the hard- and software tools

5. It is also noteworthy that a person interested in EDR data use has to invest money and time into acquiring the download equipment and receiving the necessary

[34] Work Package 3, Deliverable 3-05

training. The same applies for the interpretation of the extracted data and for acquiring the capability to use this information needed for a comprehensible accident analysis.[35]

6. It would therefore be illegitimate to consider that when the owner of the vehicle, or the driver, is no longer able to exercise direct control over the accessibility of the vehicle (for example when a vehicle is sent to the scrap yard or is stolen), the data in the EDR would be exposed to plug-in fraudulent use. In other words: If the unrealistic case should occur that someone unauthorised and inexperienced gets access to EDR data he would only have a set of digitalised dynamic and status vehicle data of which it is hardly imaginable that he can use them for a *"resulting impact upon the individual"* as the ICO guidance requires it.[36]

7. *In fine*, if the risk of fraudulent use of the vehicle's data is statistically extremely low, the fact remains that the risk of abusive linking to a person and violation of fundamental freedoms, as described in Directive 95/46/EC, is theoretically present. It is therefore not obsolete to determine to what extent the use of EDR data by different stakeholders might materialise this risk and thus endanger these rights enshrined in the Directive. The answer to this question is that the studies conducted in this project have come to the general conclusion that when taking into account the whole EDR concept, its environment, the circumstances and user scenarios for the EDR data as such *"the chances of an individual suffering detriment"*[37]–to use the wording applied by the ICO- are negligible. This does not mean that EDR data once they have become part of an accident investigation procedure and as a matter of fact have been merged with clear personal data have not to be treated as personal. This then has the same status as if the accident expert takes photos from the scene, conducts interviews with eye-witnesses or undertakes other useful investigation measures and incorporates all this in the evidential files including the information on the drivers involved. This is then not a special EDR issue any more but part of well established data flows.

8. The conclusion that EDR data can have certain though practically very limited relevance for data privacy is meanwhile founded on a broad basis. Sources to be referred to are e.a. several workshops of the annual German Traffic Court Conferences, statements of the German Data Protection Officer who sees EDRs mandatory at least for Commercial Vehicles and Busses as appropriate means and the Veronica project workshops with data privacy officers.[38]

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[35] John C. Steiner, a Californian Senior Automotive Engineer in an article presently in preparation for the German Journal "Verkehrsunfall und Fahrzeugtechnik" to be published probably in the second half of 2009, states that in the US a Crash Data Retrieval Tool (though including a number of interface options for the not yet standardized EDR world) currently costs $3,349.00 and requires a $395.00 annual support subscription plus 40 hours of training.

[36] ICO, p. 17

[37] ICO, p. 21

[38] Deutsche Akademie für Verkehrswissenschaft, 41. Deutscher Verkehrsgerichtstag 2003, AK V, p. 11 and 223, ibid. 45 Deutscher Verkehrsgerichtstag 2007, AK VII, p. 13, The Biannual Report 2005-06 of the German Federal Data Protection Officer, (Bundesdatenschutzbeauftragter, www.bfdi.bund.de, 21. Tätigkeitsbericht 2005-2006, p. 128, who sees EDR data as driving related); similar his speech on p.4 on the ADAC Congress 2006 "Der gläserne Autofahrer" (The transparent driver), www.adac.de/Verkehr/ Verkehrsexperten/glaeserner_autofahrer; similar also statements on the Erlangen interdisciplinary symposium on Digital data in devices and systems, Vieweg, Gerhäuser (Hrsg.), Digitale Daten in Geräten und Systemen – Erlanger Symposium 11./12. September 2008, RTW-Schriftenreihe, Carl Heymanns Verlag, Köln (publication expected throughout the second half of 2009) and the two joint project-workshops held with the European Academy for the Freedom of Information and Data Protection (EAID) in Berlin in March 2006 and in September 2008, see also Veronica I Final Report

6.1.3.3.3 Vocation and status of EDR Data

1. The use of EDR data in the context of research activities does not require access to the personal components of this data but the ability to process raw or anonymous information. Absolute anonymity of data is therefore necessary so that research activities do not infringe on the rights specified in the Directive. Moreover, this absolute anonymity should be accompanied by a “simplified anonymity” of the VIN. Indeed, the data relevant to the scientific community should allow the type and model of vehicle involved in the accident to be determined, as well as all aspects related to the vehicle’s status (speed, braking, etc.) or affecting the vehicle’s dynamics, and other parameters of the accident (number of passengers, weight, places in the vehicle, etc.). The simplified anonymity of the VIN is not, a priori, an obstacle to conducting research activities. Otherwise, relevant data (at least personal ones) can also be pseudomised for research activities. Pseudomisation is a simple process which may allow problems resulting from data privacy concerns to be overcome. Indeed, data is personal when related to an individual. When it comes to EDRs and research activities, it is commonly agreed that only the “technical” value of data is needed, not their link to a specific person. Since the pseudomisation process consists in changing the data’s name, it enables the use of data without necessarily alter their scientific value. Pseudomisation procedures have already been successfully applied in disease research, a research field very similar to the one real-life-in-depth accident data can be used in.

2. The processing of EDR data for any purpose other than the research activities mentioned in Article 6 of Directive 95/46/EC is mainly linked to the needs of insurance companies and the definition and application of the legal penalties that may result. It is therefore useful to examine to what extent the data which these players may need is, or is not, personal, and consequently determine whether or not the rights enshrined in the Directive are respected. In the case of insurance, the contractual relationship between the client and the insurer should cover the purpose of the use of EDR data, so that processing that may be done later is marked by the fairness and transparency required by the Directive.

3. The data recorded in the EDR can be classified into two categories according to its use:

- The most critical data with regards to the purpose of EDRs bears on the vehicle’s status and dynamics (speed, Delta-V, longitudinal and transverse acceleration, steering angle, headlights, flashers, etc.).
- Additional data for the purpose of first responders and insurance, as well as so that the judicial players can fulfil their duties with the greatest possible safeguards (Vehicle Identification Number - VIN).

4. The VIN is an alphanumeric code assigned to each vehicle placed in circulation. It is engraved on the frame, marked on the engine and included in the onboard computer. When an EDR is placed in a vehicle, the VIN of the vehicle concerned is recorded in the EDR to limit risks to the authenticity of the data. Thus,

the data that may be used shall clearly be that for the vehicle that corresponds to the VIN in the EDR, until evidence to the contrary is produced.

5. In the context of the processing of personal data, the need to link the EDR to the vehicle in which it is implanted is justified by the need to ensure that the data is indeed extracted from the vehicle involved in an accident.

6. However, the linking of the EDR with the VIN,may cause data deemed non-personal to lose its anonymous nature. It becomes, in effect, personal data which must then be treated as such throughout the entire Administrative Data Flow and respect the rights in the Directive. The fact that there is a link between an EDR and the vehicle in which the EDR was installed, a link via the VIN stored in the EDR, implies that the supposedly anonymous data may become personal if research efforts are implemented. In other words, it will be possible to deduce the identity of the driver responsible for the accident from the EDR data rendered anonymous.

7. In general, the data obtained can be made personal during the Administrative Data Flow as a function of its allocation. In fact, in the case of use by the police, the courts or by insurance companies, data extracted from the EDR must undoubtedly be linked to the person concerned.

8. Thus, according to Directive 95/46/EC, EDR data, disassociated from its nature but under certain conditions, may become personal and consequently can fall within the scope of the Directive. But what the consequences of it are is not clear when considering that the risks for abuse or manipulation are extremely low and also considering that the information obtained from an EDR is by terms of its abstract quality not so different from the information obtained in the classical accident analysis that it would be justified to treat it differently. How easy a wrong interpretation can make its way around shows the example of a statement by the "Expert Group on Accidents in the Transport Sector". The experts estimated in their report that the "*Application and use of this event recorder data is not possible in most of the Member States due to juridical hindrances in terms of protection of data privacy."* However it should be emphasised that this group, which consisted of road safety engineers, did not have any mandate to deal with legal aspects. In addition the method and the rationale leading to this conclusion are not mentioned. The study focused exclusively on the need for better accident investigation and to obtain better real-life data –objectives which these experts are clearly calling for! To speed up the implementation of EDRs for research purposes the group members apparently wanted to overcome prejudices and any thinkable obstacle thus going beyond their competence and mandate. These types of statements should therefore be considered with greatest caution.[39]

6.1.3.3.4 Consent prior to any processing of data?

1. The combination of the potential personal relevance of the data from the EDR and a theoretically low security level nevertheless leads to the obligation to process EDR (as any other) data in such a manner that it fulfils the requirements of Directive

[39] Road Accident Investigation in the European Union – Review and Recommendations;

95/46/EC, thus raising the issue of indisputable consent in private (contractual) cases, in other words, cases where there are no prevailing public interests.

2. This aspect of indisputable consent might become important when put into perspective with the EDR's security level. Indeed, the security architecture of the EDR could be regarded as a problem if we look on the aspect of vehicle theft which could also be potentially regarded as a form of data theft. The number of vehicles stolen in the European Union is increasing dramatically and is already very high.[40] But again a realistic view is required: it is improbable that a thief will steal a car that has previously been involved in an accident from which the data had not been deleted from the EDR with the thief happening to know how to download the digital information and then understand its content and finally, by coincidence, also happen to know the identity of driver involved in the accident. How will the thief make use of this information? What would be the damage to an individual? How does the thief know that the data has not already been downloaded and processed legally? And wouldn't the thief risk unveiling himself when using the data? We see from this that an evaluation of the practical conditions is always necessary.

3. Therefore, considering that as shown under 6.1.2 on "Data use outside the vehicle", it can be asserted that the development of EDRs undoubtedly proceeds from a mission of public interest, particularly in matters of road safety associated research or to better define the liability of the physical or legal entities involved in accidents.

We consider that person(s) concerned by extracted data for private intervention and subsequent processing of personal data from the EDR will have given prior consent to the use of such data in compliance with the provisions of the contract, obtaining the explicit consent of the person concerned by the EDR data, or the owner of this same data, is a sine qua non condition prior any intervention and subsequent processing of personal data extracted from the EDR. However, consent cannot be a condition sine qua non as long as the data is required by the police or the Courts or as long as the data which are used for other public needs are absolutely anonymised or pseudomised.

6.1.3.4 Conclusion

1. When it comes to understanding the processing of data, it is necessary to define the terms and conditions in real life of processing data under Articles 6 and 7 of Directive 95/46/EC, which set the conditions for the lawfulness of the data's processing, as well as Article 1, which provides that "Member States shall ensure the protection of the fundamental rights and freedoms of individuals, including their right to privacy with regards to the processing of personal data."

2. The existing, though limited potential of EDR data to become personal, the very limited risk of abuse, combined with its multiple uses by interested parties, both public and private, highlights within the already established or future administrative

[40] In Europe, the financial prejudice is estimated at € 15 billion.

data flows the necessity to safeguard the principles of loyalty as much as of lawfulness with regards to the person that the data may concern.

3. To this end, and given the standardised nature that the processing of EDR data may take in different Member States, we recommend, as a prerequisite to private processing of data, making the obtaining of consent explicit and undeniable, as a prerequisite to any private processing of data like in insurance, labour or rental contracts.

4. As for data required by the police or the Courts consent cannot be a condition sine qua non. As for road safety research purposes an anonymisation or pseudomisation process will have to be safeguarded in any law requiring the mandatory implementation of EDRs

6.2 Rule making for European EDR Technology

6.2.1 Defining data elements and data quality

6.2.1.1 Explained Table of Information Requirements

(taken from Veronica I)

No	Information Requirements	Importance*	Remarks
1	Collision Speed		Speed at moment of impact
2	Initial Speed		Speed at start of recording a/o braking
3	Speed Profile		Pre- and Post crash
4	dv		?v = Delta-v = Change in velocity due to a collision
5	Longitudinal acceleration (IP)		Impact phase (high resolution)
6	Transverse acceleration (IP)		Impact phase (high resolution)
7	Longitudinal acceleration		Pre- and Post crash (low resolution)
8	Transverse acceleration		Pre- and Post crash (low resolution)
9	Yawing		Pre crash yawing
10	Tracking		Displacement tracking of collision sequence
11	Position		Absolute position
12	Status Signals		Brake light, indicator, lights, blue light, horn ...
13	Trigger Date Time		Relative time, convertible into real time after download
14	User Action		Throttle, brake, steering, horn, clutch ...
15	Monitoring Restraint Systems		Airbags, Seat Belts
16	Monitoring ASD actions		Active Safety Devices (ESP, brake assistant, ABS) go/nogo self-diagnosis for exoneration purposes of manufacturer
17	Monitoring displayed ASD error messages		Messages on faults of ABS Systems etc for exoneration purposes of manufacturer
18	VIN/VRD		Vehicle Identification No/Vehicle Registration No; see table 11
19	Driver-ID		Key, Smart Card, Code ...
20	Monitoring Driver		Visual Monitoring

Table 6 and Fig. 9-12 Veronica I final report

*) high relevance (mainstream)
lesser relevance
low relevance (for specific purposes only)

Fig. 29: Explained table of information requirements

6.2.1.2 VERONCA and NHTSA requirements compared

6.2.1.2.1 by frequency range and data element

	Requirement		Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA)						
Data Element	Definition	Condition	Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s	Accuracy	Resolution
Longitudinal acceleration	VERONICA	R	10 Hz ± 2 g	25 Hz ± 2 g	-	25 Hz ± 2 g	10 Hz ± 2 g	± 5%	0.16 m/s² (0.016 g)
	NHTSA	NR	-	-	-	-	-	-	-
Lateral acceleration	VERONICA	R	10 Hz ± 2 g	25 Hz ± 2 g	-	25 Hz ± 2 g	10 Hz ± 2 g	± 5%	0.16 m/s² (0.016 g)
	NHTSA	NR	-	-	-	-	-	-	-
Normal acceleration	VERONICA	IR	10 Hz ± 2 g	25 Hz ± 2 g	-	25 Hz ± 2 g	10 Hz ± 2 g	± 5%	0.16 m/s² (0.016 g)
	NHTSA	NR	-	-	-	-	-	-	-
Longitudinal acceleration (IP)	VERONICA	R	-	-	250 Hz ± 50 g	-	-	± 5%	1 m/s² (0.1 g)
	NHTSA	IR	-	-	100 Hz ± 50 g [1]	-	-	± 10%	0.5 g
Lateral acceleration (IP)	VERONICA	R	-	-	250 Hz ± 50 g	-	-	± 5%	1 m/s² (0.1 g)
	NHTSA	IR	-	-	100 Hz ± 5 g [1]	-	-	± 10%	0.5 g
Normal acceleration (IP)	VERONICA	IR	-	-	250 Hz ± 50 g	-	-	± 5%	1 m/s² (0.1 g)
	NHTSA	IR	-	-	100 Hz ± 5 g [1]	-	-	± 10%	0.5 g
Δv, longitudinal	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	R	-	-	100 Hz ±100 km/h [2]	-	-	± 10%	1 km/h
Maximum Δv, longitudinal	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	R	-	-	N/A [3]	-	-	± 10%	1 km/h
Time, maximum Δv, longitudinal	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	R	-	-	N/A [3]	-	-	± 3 ms	2.5 ms
Δv, lateral	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	IR	-	-	100 Hz ±100 km/h [2]	-	-	± 10%	1 km/h
Maximum Δv, lateral	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	IR	-	-	N/A [3]	-	-	± 10%	1 km/h

	Requirement		Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA)						
Data Element	Definition	Condition	Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s	Accuracy	Resolution
Time, maximum Δv, lateral	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	IR	-	-	N/A [3]	-	-	± 3 ms	2.5 ms
Time, maximum Δv, resultant	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	IR	-	-	N/A [3]	-	-	± 3 ms	2.5 ms
Vehicle roll angle***	VERONICA	IE	-	10 Hz ± 1080° [4]	-	10 Hz ± 1080°	10 Hz ± 1080° [4]	± 10%	10°
	NHTSA	IR	-	10 Hz ± 1080°4	-	10 Hz ± 1080°	10 Hz ± 1080°4	± 10%	10°
v (Speed, vehicle indicated)	VERONICA	R	10 Hz 0-250 km/h	10 Hz 0-250 km/h	-	10 Hz 0-250 km/h	10 Hz 0-250 km/h	± (3% + 1km/h)	1 km/h
	NHTSA	R	-	2 Hz 0-200 km/h	-	-	-	± 1 km/h	1 km/h
Engine throttle, percent full	VERONICA	R	-	2 Hz 0-100%	-	-	-	± 5%	0,01
	NHTSA	R	-	2 Hz 0-100%	-	-	-	± 5%	0,01
Engine speed, in r/min	VERONICA	IR	-	2 Hz 0-10000 rpm	-	-	-	± 100 rpm	100 rpm
	NHTSA	IR	-	2 Hz 0-10000 rpm [5]	-	-	-	± 100 rpm	100 rpm
Brake status (Service brake, on, off)	VERONICA	R	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	R	-	2 Hz / OnOff	-	-	-	N/A	On and Off
ABS activity	VERONICA	IE	2 Hz / OnOff	10 Hz / OnOff	-	-	-	N/A	On and Off
	NHTSA	IR	-	2 Hz / OnOff [5]	-	-	-	N/A	On and Off
Stability control, on, off, engaged	VERONICA	IE	2 Hz / OnOffEng	10 Hz / OnOffEng	-	-	-	-	On, Off, Engaged
	NHTSA	IR	-	2 Hz / OnOffEng [5]	-	-	-	-	On, Off, Engaged
Steering wheel angle (steering input)	VERONICA	IR	2 Hz / ± 250°	10 Hz / ± 250°	-	-	-	± 5%	0,01
	NHTSA	IR	-	2 Hz / ± 250° [5]	-	-	-	± 5%	0,01
Ignition cycle, crash	VERONICA	R	-	NA / 0-60000 [6]	-	-	-	± 1 cycle	1 cycle
	NHTSA	R	-	N/A / 0-60000 [6]	-	-	-	± 1 cycle	1 cycle
Ignition cycle, download	VERONICA	R	-	-	-	-	N/A / 0-60000 [7]	± 1 cycle	1 cycle
	NHTSA	R	-	-	-	-	N/A / 0-60000 [7]	± 1 cycle	1 cycle

Data Element	Requirement		Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA)					Accuracy	Resolution
	Definition	Condition	Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s		
Safety belt status, driver	VERONICA	NR	-	N/A / OnOff [6]	-	-	-	N/A	On or Off
	NHTSA	R	-	N/A / OnOff [6]	-	-	-	N/A	On or Off
Safety belt status, front passenger	VERONICA	IE	-	N/A / OnOff [6]	-	-	-	N/A	On or Off
	NHTSA	IR	-	N/A / OnOff [6]	-	-	-	N/A	On or Off
Frontal air bag warning lamp, on, off	VERONICA	R	-	N/A / OnOff [6]	-	-	-	N/A	On or Off
	NHTSA	R	-	N/A / OnOff [6]	-	-	-	N/A	On or Off
Frontal air bag suppression switch status, front passenger	VERONICA	IR	-	N/A / OnOffAut [6]	-	-	-	N/A	On, Off or Auto
	NHTSA	IR	-	N/A / OnOffAut [6]	-	-	-	N/A	On, Off or Auto
Frontal air bag deployment, time to deploy/first stage, driver	VERONICA	R	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	R	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Frontal air bag deployment, time to deploy/first stage, front passenger	VERONICA	R	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	R	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Frontal air bag deployment, time to nth stage, driver	VERONICA	IE	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IE	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Frontal air bag deployment, time to nth stage, front passenger	VERONICA	IE	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IE	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Frontal air bag deployment, nth stage disposal, driver, y/n	VERONICA	IR	-	-	N/A / YesNo	-	-	N/A	Yes or No
	NHTSA	IR	-	-	N/A / YesNo	-	-	N/A	Yes or No
Frontal air bag deployment, nth stage disposal, front passenger, y/n	VERONICA	IR	-	-	N/A / YesNo	-	-	N/A	Yes or No
	NHTSA	IR	-	-	N/A / YesNo	-	-	N/A	Yes or No
Side air bag deployment, time to deploy, driver	VERONICA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Side air bag deployment, time to deploy, front passenger	VERONICA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms

Data Element	Requirement: Definition	Requirement: Condition	Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA): Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s	Accuracy	Resolution
Side curtain/tube air bag deployment, time to deploy, driver side	VERONICA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Side curtain/tube air bag deployment, time to deploy, front passenger side	VERONICA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Pretensioner deployment, time to fire, driver	VERONICA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Pretensioner deployment, time to fire, front passenger	VERONICA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
	NHTSA	IR	-	-	N/A / 0-250 ms	-	-	± 2 ms	1 ms
Seat track position switch, foremost, status, driver	VERONICA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
	NHTSA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
Seat track position switch, foremost, status, front passenger	VERONICA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
	NHTSA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
Occupant size classification, driver	VERONICA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
	NHTSA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
Occupant size classification, front passenger	VERONICA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
	NHTSA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
Occupant position classification, driver	VERONICA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
	NHTSA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
Occupant position classification, front passenger	VERONICA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
	NHTSA	IR	-	N/A / YesNo [6]	-	-	-	N/A	Yes or No
Multi-event, number of events (1, 2)	VERONICA	R	-	-	N/A / 1 or 2	-	-	N/A	1 or 2
	NHTSA	R	-	-	N/A / 1 or 2	-	-	N/A	1 or 2
Time from event 1 to 2	VERONICA	R	-	-	N/A / 0-5.0 s	-	-	0.s s	0.1 s
	NHTSA	R	-	-	N/A / 0-5.0 s	-	-	0.s s	0.1 s

Data Element	Requirement		Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA)					Accuracy	Resolution
	Definition	Condition	Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s		
Complete file recorded (Yes/No)	VERONICA	IR	-	-	-	-	-	-	-
	NHTSA	IR	-	-	-	Following other data	-	N/A	Yes or No
Ignition	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Indicator	VERONICA	R	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
Horn	VERONICA	R	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
Main beam	VERONICA	R	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
Dip beam	VERONICA	R	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
Parking lights	VERONICA	R	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
Temperature	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
cis-gis Horn	VERONICA	IE	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
blue light	VERONICA	IE	10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff	N/A	On or Off
	NHTSA	NR	-	-	-	-	-	-	-
Yaw angle	VERONICA	R	10 Hz / 0-360°	25 Hz / 0-360°	-	25 Hz / 0-360°	10 Hz / 0-360°	± 5°	1°
	NHTSA	NR	-	-	-	-	-	-	-
Magnetic field	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-

Data Element	Requirement: Definition	Requirement: Condition	Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s	Accuracy	Resolution
			Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA)						
Satelite Position Information	VERONICA	IR	1Hz	1Hz	-	1Hz	1Hz	N/A	Full NMEA dataset
	NHTSA	NR	-	-	-	-	-	-	-
Internal temperature	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Humidity	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Pressure	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Images outside	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Images inside	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Sound inside	VERONICA	NR	-	-	-	-	-	-	-
	NHTSA	NR	-	-	-	-	-	-	-
Trigger Date Time	VERONICA	R	-	-	N/A	-	-	+/- 60 s	1 ms
	NHTSA	NR	-	-	-	-	-	-	-
Download Date Time	VERONICA	R	-	-	-	-	N/A	+/- 60 s	1 ms
	NHTSA	NR	-	-	-	-	-	-	-

*) frequency of finally decoded data

**) or -0,04 s to End of Trigger + 0,04 s (Trigger ± 10 values)

***) if required in UNECE R13 / R13H

R Required

1) 0 to 250 ms

2) 0 to 250 ms or 0 to End of Event Time plus 30 ms, whichever is shorter

3) 0 to 300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter

4) -1.0 up to 5.0 s

5) -5.0 to 0 s

Data Element	Requirement		Frequency* / Range (VERONICA II) - Recording interval/time (NHTSA)					Accuracy	Resolution
	Definition	Condition	Early Precrash -30s to -5s	Near Precrash -5s to -0,0s	Crash -0,04s to +0,25s**	Near Postcrash +0,0s to +5s	Far Postcrash +5s to +10s		

IE If equipped with

IR If recorded

NR Not required

6) -1.0 s

7) at time of download

Fig. 30: Tabled data element requirements

6.2.1.2.2 by time zones and information requirements

Definition of time zones

Time relative to event (time zero)

No	Information Requirements	Importance*	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	Crash	1	2	3	4	5	6	7	8	9	10
1	Collision Speed			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
2	Initial Speed																																											
3	Speed Profile																																											
4	dv			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
5	Longitudinal acceleration (IP)			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
6	Transverse acceleration (IP)			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
7	Longitudinal acceleration																																											
8	Transverse acceleration																																											
9	Yawing																																											
10	Tracking			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
11	Position			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
12	Status Signals																																											
13	Trigger Date Time			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
14	User Action																																											
15	Monitoring Restraint Systems			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x												x	x	x	x	x	x	x	x	x	x
16	Monitoring ASD actions																																	x	x	x	x	x	x	x	x	x	x	x
17	Monitoring displayed ASD error messages			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
18	VIN/VRD			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	x	x	x	x	x	x	x	x	x	x
19	Driver-ID			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
20	Monitoring Driver			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

*) high relevance (mainstream)
lesser relevance
low relevance (for specific purposes only)

data required

Fig. 31: Tabled definition of information requirements by time zones

6.2.1.2.3 NHTSA Fulfilment of Time Zones

Time zones NHTSA

Time relative to event (time zero)

No	Information Requirements	Importance*	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	Crash	1	2	3	4	5	6	7	8	9	10
1	Collision Speed			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
2	Initial Speed																																												
3	Speed Profile																																												
4	dv			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
5	Longitudinal acceleration (IP)			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
6	Transverse acceleration (IP)			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
7	Longitudinal acceleration																																												
8	Transverse acceleration																																												
9	Yawing																																												
10	Tracking			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	Position			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	Status Signals																																												
13	Trigger Date Time			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
14	User Action																																												
15	Monitoring Restraint Systems			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																						
16	Monitoring ASD actions																																		X	X	X	X	X	X	X	X	X	X	X
17	Monitoring displayed ASD error messages			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
18	VIN/VRD			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	X	X	X	X	X	X	X
19	Driver-ID			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
20	Monitoring Driver			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

*) high relevance (mainstream)
lesser relevance
low relevance (for specific purposes only)

requirement fullfilled
requirement fullfilled with limitations
requirement paritally fullfilled
requirement not fullfilled

Fig. 32: Tabled NHTSA fulfilment of time zones

6.2.1.2.4 VERONICA Fulfilment of Time Zones

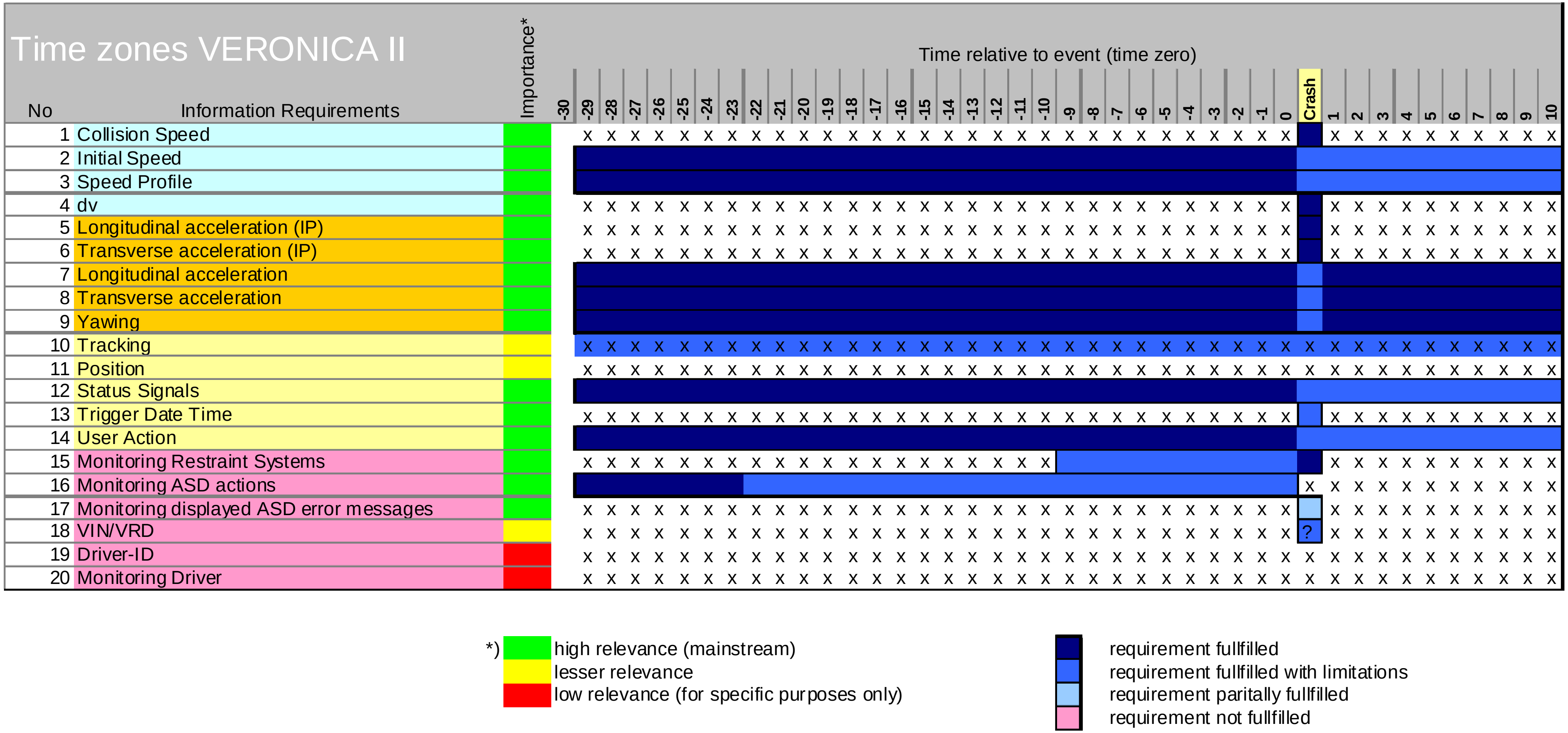

Fig. 33: Tabled VERONICA fulfilment of time zones

6.2.1.2.5 Conclusions for European EDR requirements

The requirements by frequency/range, accuracy, resolution and crash phases are fulfilled by the NHTSA standard only to a very low degree whereas the VERONICA values cover the requirements to a far higher degree.

6.2.1.2.6 Future work items for consideration

Since June 2008 VERONICA obtains a liaison status with CEN TC278 WG15 which works on eCall operational requirements. The following conclusions for the relation between eCall and EDR can be drawn:

- The implementation of eCall as well as of EDR both aim at reducing the number of fatalities in Europe.
- The 'trigger' functionalities are not defined by CEN. This is left to the vehicle manufacturers. But the algorithm which triggers an eCall can also be used for the recording of hard event collisions and vice versa.
- In a future step a link from EDR to eCall could provide information on crash severity to be transmitted to the PSAPs and rescue centres.
- It was also confirmed by medical experts that there is a need to learn more about the relation between crash severity and vehicle damages on one side and injury severity and the direction the impact comes from on the other.
- It was also seen that there was an issue in avoiding false '112' alarms.
- eCall modules according to an informal comment received from one OEM provide a large amount of information. An EDR might be realised by means of a software extension.
- EDR should also record when an eCall was transmitted. It is difficult to decide, whether the last position data are valid or not, because the GPS signal might have been masked by a tunnel, high buildings etc. To check the quality it would be helpful to know how much time (seconds) has elapsed between the last (3) position information and the moment of the E-Call triggering. GPS and other position systems provide a time signal (see NMEA data set). As a side effect of eCall the position of the vehicle will be recorded as well.

6.2.2 Tables of Data Elements by VERONICA and NHTSA requirements

Where and when reasonable the project team accepted the NHTSA requirements also for the European EDR requirements; however in important cases, in particular for the pre- and post crash acceleration parameters the requirement levels had to be raised to the state of the art of comprehensive accident analysis requirements.

For the details see the tables on the next pages which are shown in two parts:

Part I presents 47 numbered Data Elements required for European Event Data Recording

Part II presents Data Elements not required for European Event Data Recording

6.2.2.1 Explanation of the used terms and abbreviations (if not self explanatory)

Data element number is an ongoing number for Data Elements required for European Event Data Recording and is used as a specific number for every data element as well as the ***acronyms***, which consist of some alphabetic characters as an abbreviation for the data element name.

Condition**:** Three different conditions are specified:

R stands for *"required"* and will have to be recorded by every EDR system

IE stands for *"if equipped"* and will have to be recorded only if the vehicle is equipped with the specified system or signal source.

IR stands for *"if recorded"* and means that if the vehicle is equipped with a specific system and the data are recorded, the data should be recorded in the specified way.

Description / operation**:** verbal description of the data element and its basic conditions.

Data definition/sign convention/coordinate system**:** description of necessary additional information concerning definition, sign and direction of the data set

Sampling frequency and range is defined phase dependant within the VERONICA II project. There are five phases which are defined as follows

- ***Early pre-crash*** is -30sec to -5sec to the crash
- ***Near pre-crash*** is -5sec to 0sec to the crash
- ***Crash*** is during the crash phase (-0.04sec to +0.25sec)
- ***Near post-crash*** is 0sec to 5sec after the crash

- ***Far post-crash*** is 5sec to 10sec after the crash
- ***Crash*** is defined as fulfilment of the trigger criteria

***Data format, data element and its parameter group according to J1939-71*:** especially for the purpose of retrofit stand-alone versions of EDR's or partly integrated systems it is strongly recommended that the above is defined by the responsible standardisation body. These fields are intentionally left blank until the standardisation is completed.

6.2.2.2 Part I: Data Elements required for European Event Data Recording

<table>
<tr><td>Data element number: 1</td><td>Data element name:
Trigger Date Time</td><td>Acronyms:
TDT</td><td>Condition:
R</td></tr>
<tr><td colspan="4">Description/operation/filter class:
The time and date at which the EDR detected an event. Date may be derived from a GPS receiver or an on-board real-time clock. Will be recorded in UTC.</td></tr>
<tr><td colspan="2">Accident investigation uses:
Provides the time, day, month, and year that a triggering event occurred.</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="2">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Resolution:
1 ms</td><td colspan="2">Accuracy:
+/- 60 s</td></tr>
<tr><td colspan="4">Sampling frequency and range: Phase dependant</td></tr>
</table>

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks:	

<table>
<tr><td>Data element number: 2</td><td colspan="2">Data element name:
Longitudinal acceleration</td><td>Acronyms:
Ax</td><td>Condition:
R</td></tr>
<tr><td colspan="5">Description/operation/filter class:
Vehicle acceleration vs. time in the longitudinal (fore-aft) direction during pre-crash and post-crash phase.
Records the pre-crash and post-crash kinematics of the vehicle.
EDR may record the data given by an accelerometer of ABS/ESP control unit.</td></tr>
<tr><td colspan="3">Accident investigation uses:
Describes the longitudinal motion of the vehicle during pre-crash and post-crash phase. Enables cross check of wheel speed and detection of minor serius front or back impacts (passenger car / pedestrian).</td><td colspan="2">Possible alternative/additional uses:
May help infer driver inputs (braking/accelerating)</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
DIN 70000 defines the sign convention and coordinate system (forward to positive).
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
0.16 m/s² (0.016 g)</td><td colspan="2">Accuracy:
± 5%</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>10 Hz ± 2 g</td><td>25 Hz ± 2 g</td><td>-</td><td>25 Hz ± 2 g</td><td>10 Hz ± 2 g</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

Data element number: 3	**Data element name:** Lateral acceleration	**Acronyms:** Ay	**Condition:** R

Description/operation/filter class: Vehicle acceleration vs time during pre-crash and post-crash phase (lateral direction). Records the pre-crash and post-crah kinematics of the vehicle. Typically the EDR may record the data given by an accelerometer of ABS/ESP control unit.

Accident investigation uses: Describes the lateral motion of the vehicle during pre-crash and post-crash phase. Enables detection of minor serious side impact. May show cornering behavior.	**Possible alternative/additional uses:** May help infer driver inputs (steering) or possible accident causation. Data could be an aid to access rollover event.
Data definition/sign convention/coordinate system: DIN 70000 defines the sign convention and coordinate system. (lateral to the left is positive from vehicle center of gravity) **Special cases:**	
Resolution: 0.16 m/s² (0.016 g)	**Accuracy:** ± 5%

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
10 Hz ± 2 g	25 Hz ± 2 g	-	25 Hz ± 2 g	10 Hz ± 2 g

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

Data element number: 4	**Data element name:** Lateral acceleration (IP)	**Acronyms:** AyIP	**Condition:** R

Description/operation/filter class: The acceleration in the lateral (side to side) direction measured during impact phase. Determines the lateral impact aspects of a crash. Can be combined with the other acceleration channels to determine principal direction of force (PDOF) and intensity of force (change of velocity).

Accident investigation uses: Describes the motion in lateral direction of the vehicle during the time of the crash.	**Possible alternative/additional uses:** Supports infrastructure safety evaluation and statistical hazard identification
Data definition/sign convention/coordinate system: DIN 70000 defines the sign convention and coordinate system. (lateral to the left is positive from vehicle center of gravity) **Special cases:**	
Resolution: 1 m/s² (0.1 g)	**Accuracy:** ± 5%

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	250 Hz ± 50 g	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 5</td><td colspan="3">Data element name:
Longitudinal acceleration (IP)</td><td>Acronyms:
AxIP</td><td>Condition:
R</td></tr>
<tr><td colspan="6">Description/operation/filter class:
The acceleration in the longitudinal (fore-aft) direction measured during impact phase.
Determines the longitudinal impact aspects of a crash. Can be combined with the other acceleration channels to determine principal direction of force (PDOF) and intensity of force (change of velocity).</td></tr>
<tr><td colspan="4">Accident investigation uses:
Describes the motion in longitudinal direction of the vehicle during the time of the crash.</td><td colspan="2">Possible alternative/additional uses:
Supports infrastructure safety evaluation and statistical hazard identification.</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
DIN 70000 defines the sign convention and coordinate system (forward to positive).
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="4">Resolution:
1 m/s² (0.1 g)</td><td colspan="2">Accuracy:
± 5%</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">250 Hz ± 50 g</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

Data element number: 6	**Data element name:** v (Speed, vehicle indicated)	**Acronyms:** VSI	**Condition:** R

Description/operation/filter class:

Indicates the speed of the vehicle, typically the wheel speed, prior to, during, and after an event trigger occurs. Data may be obtained from ABS system information.

This metric is related to other metrics such as brake application and traction control.

Accident investigation uses:	**Possible alternative/additional uses:**
Indicates the initial speed of the vehicle. Indicates the measured, not necessarily the absolute speed of the vehicle at the time surrounding the crash.	Infer vehicle dynamics prior to and after the event (e.g. skidding).
Data definition/sign convention/coordinate system: Absolute value **Special cases:**	
Resolution: 1 km/h	**Accuracy:** ± (3% + 1km/h)

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
10 Hz 0-250 km/h	10 Hz 0-250 km/h	-	10 Hz 0-250 km/h	10 Hz 0-250 km/h

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 7</td><td colspan="2">Data element name:
Engine throttle, percent full</td><td>Acronyms:
ET</td><td>Condition:
R</td></tr>
<tr><td colspan="5">Description/operation/filter class:
Position of the engine’s throttle, expressed as a percentage of full throttle.
Measure of driver’s control input to engine. Engine control module may read the throttle position sensor and presents that data on the vehicle’s data network.</td></tr>
<tr><td colspan="3">Accident investigation uses:
Indicates the driver control input to the engine</td><td colspan="2">Possible alternative/additional uses:
Data acquired may resolve so-called sudden unintended acceleration (SUA) issues.</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Data range: 0 to 100%
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
0,01</td><td colspan="2">Accuracy:
± 5%</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>2 Hz 0-100%</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

Data element number: 8	**Data element name:** Brake status (Service brake, on, off)	**Acronyms:** BAS	**Condition:** R
Description/operation/filter class: Represents service brake activity request. This data will be indicated by the signal requesting the activation of the brake lamp.			
Accident investigation uses: Service brake activity at the time surrounding the event trigger.	**Possible alternative/additional uses:**		
Data definition/sign convention/coordinate system: **Special cases:**			
Resolution: On or Off	**Accuracy:** N/A		

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks: Time accuracy has to be within (+/- 20msec).	

Data element number: 9	**Data element name:** Ignition cycle, crash	**Acronyms:** ICE	**Condition:** R	
Description/operation/filter class: Indicates the number of times the ignition has been cycled starting from the time the vehicle was manufactured and ending on the cycle in which the event occurred. Measures the vehicle's usage in terms of ignition cycles. Counter.				
Accident investigation uses: Provides the number of ignition switch cycles from "off" to "on" of the vehicle from its first use to the time of the event		**Possible alternative/additional uses:**		
Data definition/sign convention/coordinate system: **Special cases:**				
Resolution: 1 cycle		**Accuracy:** ± 1 cycle		
Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	0-60000	-	-	-
Data format:		**Discussion/references:** None		
Data element according J1939-71:		**Parameter Group Number acc. J1939-71:**		
Remarks:				

Data element number: 10	**Data element name:** Ignition cycle, download	**Acronyms:** ICCI	**Condition:** R
Description/operation/filter class: Indicates the number of times the ignition has been cycled starting from the time the vehicle was manufactured and ending on the cycle in which the event has occurred. Measures the vehicle's usage in terms of ignition cycles. Counter.			
Accident investigation uses: Provides the number of ignition switch cycles from "off" to "on" of the vehicle from its first use to the time of the download of the event.	**Possible alternative/additional uses:**		
Data definition/sign convention/coordinate system: **Special cases:**			
Resolution: 1 cycle	**Accuracy:** ± 1 cycle		
Sampling frequency and range: Phase dependant			

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	-	-	0-60000

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks: Data set is only provided to the download interface if an event is stored in a slot	

<table>
<tr><td>Data element number: 11</td><td>Data element name:
Frontal air bag warning lamp, on, off</td><td>Acronyms:
ILAB</td><td>Condition:
R</td></tr>
<tr><td colspan="4">Description/operation/filter class:
Indicate if air bag warning lamp is lighted. Indicate if occupant restraints and engaged. Status light upon engine start or ignition key on.</td></tr>
<tr><td colspan="2">Accident investigation uses:
Provides an indication as to the operational readiness of the air bag system prior to the event. Could also be used to provide the operational readiness status of the restraint systems (i.e., seat belt).</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="2">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Resolution:
On or Off</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="4">Sampling frequency and range: Phase dependant</td></tr>
</table>

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	N/A / OnOff 6	-	-	-

<table>
<tr><td>Data format:</td><td>Discussion/references:
None</td></tr>
<tr><td>Data element according J1939-71:</td><td>Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="2">Remarks:</td></tr>
</table>

<table>
<tr><td>Data element number: 12</td><td colspan="3">Data element name:
Frontal air bag deployment, time to deploy/first stage, driver</td><td>Acronyms:
ABTB</td><td>Condition:
R</td></tr>
<tr><td colspan="6">Description/operation/filter class:
The EDR records the time at which the restraint system’s ECM authorized the driver’s first-stage air bag to activate. The manufacturer of the restraint system programs the command instructions into the ECM based upon predetermined authorized scenarios.</td></tr>
<tr><td colspan="3">Accident investigation uses:
This data records the elapsed time from the time of the initial triggering event to the time of the firststage air bag deployment.</td><td colspan="3">Possible alternative/additional uses:
This time history will also include the signal provided to the pretensioners associated with the driver’s air bag.</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
1 ms</td><td colspan="3">Accuracy:
± 2 ms</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>N/A / 0 to 250 ms</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

<table>
<tr><td>Data element number: 13</td><td colspan="3">Data element name:
Frontal air bag deployment, time to deploy/first stage, front passenger</td><td>Acronyms:
ATEF</td><td>Condition:
R</td></tr>
<tr><td colspan="6">Description/operation/filter class:
The EDR records the time at which the restraint system’s ECM authorized the front passenger's first-stage air bag to activate. The manufacturer of the restraint system programs the command instructions into the ECM based upon predetermined authorized scenarios.</td></tr>
<tr><td colspan="3">Accident investigation uses:
This data records the elapsed time from the time of the initial triggering event to the time of the firststage air bag deployment.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
1 ms</td><td colspan="3">Accuracy:
± 2 ms</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>N/A / 0-250 ms</td><td colspan="2">-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

Data element number: 14	**Data element name:** Multi-event, number of events (1, 2, 3)	**Acronyms:** MEN	**Condition:** R

Description/operation/filter class:
Number of recorded events since last download or system initialization.
Number of trigger events per impact.

Accident investigation uses:	**Possible alternative/additional uses:** defined to minimum 500msec
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 or 2 or 3	**Accuracy:** N/A

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 1 or 2 or 3	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:
Definition: One event may have one or more impacts.
High resolution phase (defined within this table as crash) per event is defined to a minimum time of 500msec.The EDR controlls by usage of an given trigger control if the trigger condition is fulfilled.

The event is stored within this time and an additional 40msec before and 40 msec after the trigger condition was fulfilled.

<table>
<tr><td colspan="5">Data element number: 15</td><td colspan="7">Data element name:
Time from event 1 to 2</td><td colspan="4">Acronyms:
TBE</td><td colspan="4">Condition:
R</td></tr>
<tr><td colspan="20">Description/operation/filter class:
Elapsed time between two recorded impact events. Timing between events to understand the relative proximity of triggering events. Derived from EDR triggering event data.</td></tr>
<tr><td colspan="11">Accident investigation uses:</td><td colspan="9">Possible alternative/additional uses:</td></tr>
<tr><td colspan="11">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="9"></td></tr>
<tr><td colspan="11">Resolution:
0.1 s</td><td colspan="9">Accuracy:
0.s s</td></tr>
<tr><td colspan="20">Sampling frequency and range: Phase dependant</td></tr>
<tr><td colspan="4">Early pre-crash</td><td colspan="4">Near pre-crash</td><td colspan="4">Crash</td><td colspan="4">Near post-crash</td><td colspan="4">Far post-crash</td></tr>
<tr><td colspan="4">-</td><td colspan="4">-</td><td colspan="4">N/A / 0-5.0 s</td><td colspan="4">-</td><td colspan="4">-</td></tr>
<tr><td colspan="9">Data format:</td><td colspan="11">Discussion/references:
None</td></tr>
<tr><td colspan="9">Data element according J1939-71:</td><td colspan="11">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="20">Remarks:</td></tr>
</table>

<table>
<tr><td>Data element number: 16</td><td>Data element name:
Horn</td><td colspan="2">Acronyms:
Ho</td><td>Condition:
R</td></tr>
<tr><td colspan="5">Description/operation/filter class:
Flag to indicate whether horn activation was requested (on).</td></tr>
<tr><td colspan="3">Accident investigation uses:
Determine driver action prior to an event.</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
On or Off</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>10 Hz / OnOff</td><td>25 Hz / OnOff</td><td>-</td><td>25 Hz / OnOff</td><td>10 Hz / OnOff</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:
Time accuracy has to be within (+/- 50msec).</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number: 17</td><td colspan="3">Data element name:
Main beam</td><td>Acronyms:
LXH</td><td>Condition:
R</td></tr>
<tr><td colspan="7">Description/operation/filter class:
Flag to indicate whether main beam lamps were illuminated (on) or not illuminated (off). Switch to turn on activated or not activated.</td></tr>
<tr><td colspan="4">Accident investigation uses:
Determine operating status of headlight system prior to an event.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="4">Resolution:
On or Off</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="7">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>10 Hz / OnOff</td><td>25 Hz / OnOff</td><td>-</td><td colspan="2">25 Hz / OnOff</td><td colspan="2">10 Hz / OnOff</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="4">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="4">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="7">Remarks:
Time accuracy has to be within (+/- 50msec).</td></tr>
</table>

<table>
<tr><td>Data element number: 18</td><td colspan="3">Data element name:
Dip beam / low beam</td><td>Acronyms:
LEL</td><td>Condition:
R</td></tr>
<tr><td colspan="6">Description/operation/filter class:
Flag to indicate whether low beam lamp was illuminated (on) or not illuminated (off). Signal to turn on activated or not activated.</td></tr>
<tr><td colspan="3">Accident investigation uses:
Determine whether lighting was being used prior to the triggering event or not.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
On or Off</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>10 Hz / OnOff</td><td>25 Hz / OnOff</td><td colspan="2">-</td><td>25 Hz / OnOff</td><td>10 Hz / OnOff</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
Time accuracy has to be within (+/- 50msec).</td></tr>
</table>

<table>
<tr><td>Data element number: 19</td><td colspan="2">Data element name:
Parking lights</td><td>Acronyms:
LEP</td><td>Condition:
R</td></tr>
<tr><td colspan="5">Description/operation/filter class:
Flag to indicate whether parking lamp was illuminated (on) or not illuminated (off) by recording whether signal to turn on activated or not activated.
Indicates a request of the main switch.</td></tr>
<tr><td colspan="3">Accident investigation uses:
Determine whether parking lighting was being used prior to the triggering event or not.</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
On or Off</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>10 Hz / OnOff</td><td>25 Hz / OnOff</td><td>-</td><td>25 Hz / OnOff</td><td>10 Hz / OnOff</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:
Time accuracy has to be within (+/- 50msec).</td></tr>
</table>

<table>
<tr><td>Data element number: 20</td><td>Data element name:
Indicator</td><td>Acronyms:
ST</td><td>Condition:
R</td></tr>
<tr><td colspan="4">Description/operation/filter class:
Represents turn signal request. This data will be indicated by the signal requesting the activation of the turn indicators.</td></tr>
<tr><td colspan="2">Accident investigation uses:
Turn signal lever status for a left or right turn at the time surrounding the event trigger. Indicates the usage of the hazard warning system and by frequency the functionality of the whole system.</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="2">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Resolution:
On or Off</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="4">Sampling frequency and range: Phase dependant</td></tr>
</table>

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff

<table>
<tr><td>Data format:</td><td>Discussion/references:
None</td></tr>
<tr><td>Data element according J1939-71:</td><td>Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="2">Remarks:
Time accuracy has to be within (+/- 50msec)</td></tr>
</table>

Data element number: 21	**Data element name:** Yaw rate	**Acronyms:** YRz	**Condition:** R

Description/operation/filter class:
Vehicle yaw rate (angular velocity) about vertical axis (z-axis).
Vehicle yaw rate at the time surrounding the event trigger.
Z-axis gyro, inertial measurement unit.

Accident investigation uses:	**Possible alternative/additional uses:**
The yaw rate describes the speed of the rotation around the vertical axis (z-axis) of the vehicle at the time surrounding the event trigger.	This type of crash data could support DOT infrastructure safety evaluation and statistical hazard identification.
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1°/s	**Accuracy:** ± 5°/s

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
10 Hz / ±180°/s	25 Hz / ±180°/s	-	25 Hz / ±180°/s	10 Hz / ±180°/s

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:
Accuracy during impact phase may be worse than specified

<table>
<tr><td>Data element number: 22</td><td>Data element name:
Safety belt status, driver</td><td>Acronyms:
ResD</td><td colspan="2">Condition:
R
R</td></tr>
<tr><td colspan="5">Description/operation/filter class:
The driver’s seat belt connector communicates with the ECM to determine if the seat belt is connected or not. This seat belt status is also recorded by the EDR.</td></tr>
<tr><td colspan="3">Accident investigation uses:
This signal provides the data that reports the utilization of the driver’s seat belt/shoulder harness at the time surrounding the triggering event.</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
On or Off</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>N/A / OnOff</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

Data element number: 23	**Data element name:** Download Date Time		**Acronyms:** DDT	**Condition:** R
Description/operation/filter class: The time and date at which an event has been downloaded from the EDR. Date may be derived from a GPS receiver or an on-board real-time clock.				
Accident investigation uses: Provides the time, day, month, and year that a triggering event has been downloaded.			**Possible alternative/additional uses:**	
Data definition/sign convention/coordinate system: **Special cases:**				
Resolution: 1 s			**Accuracy:** +/- 60 s	
Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	-	-	N/A
Data format:		**Discussion/references:** None		
Data element according J1939-71:		**Parameter Group Number acc. J1939-71:**		
Remarks: Data set is only provided to the download interface if an event is stored in a slot.				

Data element number: 24	**Data element name:** Vehicle roll angle	**Acronyms:** RRX	**Condition:** IE

Description/operation/filter class:
Vehicle Roll Rate (angular velocity) about longitudinal axis (x-axis).
Vehicle roll rate at the time surrounding the crash.
X-axis gyro, inertial measurement unit.

Accident investigation uses:	**Possible alternative/additional uses:**
The roll angle describes the speed of rotation around the longitudinal axis of the vehicle during precrash and post-crash phase.	Supports infrastructure safety evaluation and statistical hazard identification.
Data definition/sign convention/coordinate system: DIN 70000 (clockwise arround the direction of the longitudinal axes is positive) **Special cases:**	
Resolution: 10°	**Accuracy:** ± 10%

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	10 Hz ± 1080°4	-	10 Hz ± 1080°	10 Hz ± 1080°4

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 25</td><td colspan="3">Data element name:
ABS activity</td><td>Acronyms:
ABS</td><td>Condition:
IE</td></tr>
<tr><td colspan="6">Description/operation/filter class:
Represents ABS activity</td></tr>
<tr><td colspan="3">Accident investigation uses:
ABS activity at the time surrounding the event trigger</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
On and Off</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>2 Hz / OnOff</td><td>10 Hz / OnOff</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number: 26</td><td colspan="3">Data element name:
Stability control, on, off, engaged</td><td colspan="2">Acronyms:
BSC</td><td>Condition:
IE</td></tr>
<tr><td colspan="8">Description/operation/filter class:
Determines the status of the stability control system. This data would be indicated by the activation of the stability control indicator lamp.</td></tr>
<tr><td colspan="4">Accident investigation uses:
Stability control status at the time surrounding the event trigger</td><td colspan="4">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="4"></td></tr>
<tr><td colspan="4">Resolution:
On, Off, Engaged</td><td colspan="4">Accuracy:
-</td></tr>
<tr><td colspan="8">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>2 Hz / OnOffEng</td><td colspan="2">10 Hz / OnOffEng</td><td colspan="2">-</td><td colspan="2">-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="5">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="5">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="8">Remarks:</td></tr>
</table>

<table>
<tr><td>Data element number: 27</td><td colspan="2">Data element name:
Safety belt status, front passenger</td><td>Acronyms:
ResFP</td><td>Condition:
IE</td></tr>
<tr><td colspan="5">Description/operation/filter class:
The passenger’s seat belt connector communicates with the ECM to determine if the seat belt is connected or not. This seat belt status is also recorded by the EDR. IR signaling can indicate vehicle occupancy and seat belt status. The restraints system’s ECM monitors the passenger’s seat belt connection status. Depending on the connection status, an air bag deployment scenario has been preprogrammed.</td></tr>
<tr><td colspan="3">Accident investigation uses:
This signal provides the data that reports the utilization of the passenger’s seat belt/shoulder harness at the time surrounding the triggering event.</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
On or Off</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>N/A / OnOff</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

Data element number: 28	**Data element name:** Frontal air bag deployment, time to nth stage, driver	**Acronyms:** ADSS	**Condition:** IE

Description/operation/filter class: The EDR records the time at which the restraint system's ECM authorized the driver's nth-stage air bag to activate. The manufacturer of the restraint system programs the command instructions into the ECM based upon predetermined authorized scenarios.

Accident investigation uses: Provides the time history from the initial triggering event to the time that the driver's nth-stage air bag was deployed or cycled.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 ms	**Accuracy:** ± 2 ms

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 0-250 ms	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

Data element number: 29	**Data element name:** cis-gis Horn	**Acronyms:** CGH	**Condition:** IE

Description/operation/filter class: Flag to indicate whether cis-gis horn was was on or off by recording whether signal to turn on activated or not activated in emergency vehicles.

Accident investigation uses: Determine whether cis-gis horn was being used prior to the triggering event or not.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: On or Off	**Accuracy:** N/A

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
10 Hz / OnOff	25 Hz / OnOff	-	25 Hz / OnOff	10 Hz / OnOff

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks: It is of interest if the system was really working.

<table>
<tr><td>Data element number: 30</td><td colspan="3">Data element name:
blue light</td><td>Acronyms:
BL</td><td>Condition:
IE</td></tr>
<tr><td colspan="6">Description/operation/filter class:
Flag to indicate whether blue light was on or off by recording whether signal to turn on activated or not activated in emergency vehicles.</td></tr>
<tr><td colspan="3">Accident investigation uses:
Determine whether blue light was being used prior to the triggering event or not.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
On or Off</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>10 Hz / OnOff</td><td>25 Hz / OnOff</td><td colspan="2">-</td><td>25 Hz / OnOff</td><td>10 Hz / OnOff</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
It is of interest if the system was really working.</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number: 31</td><td colspan="2">Data element name:
Monitoring active safety devices</td><td>Acronyms:
MASD</td><td>Condition:
IE</td></tr>
<tr><td colspan="6">Description/operation/filter class:
Monitoring the output signals from active safety systems such as distance control, brake assist and future systems.
Flags to indicate whether active safety devices have been active or given active feedbck to the driver.</td></tr>
<tr><td colspan="3">Accident investigation uses:</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
On, Off or Active</td><td colspan="3">Accuracy:</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

Data element number: 32	Data element name: Normal acceleration	Acronyms: Az	Condition: IR

Description/operation/filter class:
Vehicles gravity vs time during pre-crash and post-crash phase. Records the pre-crash and post-crash behavior of the normal acceleration of the vehicle.
Typically the EDR may record the data given by an accelerometer of ABS/ESP control unit.

Accident investigation uses:	**Possible alternative/additional uses:**
Data will be an aid to access rollover event.	Describes the gravity of the vehicle during pre-crash and post-crash phase. Data could help to trigger E-Call.
Data definition/sign convention/coordinate system: DIN 70000 defines the sign convention and coordinate system. (upright is positive from vehicle center of gravity) **Special cases:**	
Resolution: 0.16 m/s² (0.016 g)	**Accuracy:** ± 5%

Sampling frequency and range: Phase dependant

Early pre-crash	Near pre-crash	Crash	Near post-crash	Far post-crash
10 Hz ± 2 g	25 Hz ± 2 g	-	25 Hz ± 2 g	10 Hz ± 2 g

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 33</td><td colspan="2">Data element name:
Normal acceleration (IP)</td><td>Acronyms:
AzIP</td><td>Condition:
IR</td></tr>
<tr><td colspan="5">Description/operation/filter class:
The acceleration in the vertical (up-down) direction measured during impact phase.
Determines the vertical impact aspects of a crash. Can be combined with the other acceleration channels to determine principal direction of force (PDOF) and intensity of force (change of velocity).</td></tr>
<tr><td colspan="3">Accident investigation uses:
Helps to describe the motion of the vehicle in the vertical axis during a crash.</td><td colspan="2">Possible alternative/additional uses:
Supports infrastructure safety evaluation and statistical hazard identification.</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
DIN 70000 defines the sign convention and coordinate system. (upright is positive from vehicle center of gravity)
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
1 m/s² (0.1 g)</td><td colspan="2">Accuracy:
± 5%</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>250 Hz ± 50 g</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

<table>
<tr><td>Data element number: 34</td><td colspan="2">Data element name:
Engine speed, in rpm</td><td>Acronyms:
ES</td><td>Condition:
IR</td></tr>
<tr><td colspan="5">Description/operation/filter class:
Engine speed, expressed in revolutions per minute (r/min).
Measure of engine’s speed.
Engine control module may determine the engine speed and present that data on the vehicle’s data network.</td></tr>
<tr><td colspan="3">Accident investigation uses:
Establishes the relationship between accelerator control and engine r/min</td><td colspan="2">Possible alternative/additional uses:
May help infer driver inputs or possible accident causation. Can be used for engine diagnosis purposes</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
100 rpm</td><td colspan="2">Accuracy:
± 100 rpm</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>2 Hz 0-10000 rpm</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

Data element number: 35	**Data element name:** Steering wheel angle (steering input)	**Acronyms:** SWP	**Condition:** IR

Description/operation/filter class:

This data element describes the angular position and direction, clockwise (CW) or counterclockwise (CCW), of the steering wheel when measured from the wheel's neutral position at the time surrounding the event trigger.

The operation is defined as the steering wheel rotation, CW or CCW that causes the front wheels of the vehicle to turn right (CW) or left (CCW). The steering wheel is typically but not necessarily mechanically connected to the front wheels through the various mechanical subsystems, and the resulting steering gear ratio (from the steering wheel angle to the road angle) varies between vehicles types and models. The range of steering wheel angle will go from 0° to ±720° and may result in turning the fron t wheels up to 45°, in the left or right directions.

Accident investigation uses: Indicates the driver's steering activity.	**Possible alternative/additional uses:** Helps to indicate active steering devices actions.
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 0,01	**Accuracy:** ± 5%

Sampling frequency and range: Phase dependant

Early pre-crash	Near pre-crash	Crash	Near post-crash	Far post-crash
2 Hz / ± 250°	10 Hz / ± 250°	-	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

Data element number: 36	Data element name: Frontal air bag suppression switch status, front passenger	Acronyms: ASP	Condition: IR

Description/operation/filter class: This data element will indicate the suppression status of the passenger(s) air bag that can be activated or not activated using the vehicle's ignition key. The passenger's air bag suppression status is controllable (on/off) by an individual, with the vehicle key. If the suppression status is in the "on" position, the passenger air bag is activated for deployment.

Accident investigation uses: This data records whether the passenger's air bag system was manually placed in a "off" or "on" position at the time surrounding the event trigger.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: On, Off or Auto	**Accuracy:** N/A

Sampling frequency and range: Phase dependant

Early pre-crash	Near pre-crash	Crash	Near post-crash	Far post-crash
-	N/A / OnOffAut 6	-	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

Data element number: 37	**Data element name:** Frontal air bag deployment, time to nth stage, front passenger	**Acronyms:** PSSD	**Condition:** IR

Description/operation/filter class: The EDR records the time at which the restraint system's ECM authorized the front passenger's nth-stage air bag to activate. The manufacturer of the restraint system programs the command instructions into the ECM based upon predetermined authorized scenarios.

Accident investigation uses: This data records the elapsed time from the time of the initial triggering event to the time of the nth-stage air bag deployment.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 ms	**Accuracy:** ± 2 ms

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 0-250 ms	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 38</td><td colspan="3">Data element name:
Frontal air bag deployment, nth stage disposal, driver, y/n</td><td>Acronyms:
ADLd</td><td>Condition:
IR</td></tr>
<tr><td colspan="6">Description/operation/filter class:
Where there are multi-stage driver air bags, this data element provides the indication of the air bag deployment level. The deployment level is preprogrammed into the ECM based upon predetermined, authorized scenarios.
During a slow-speed collision, the multi stage inflator system for the steering wheel mounted air bag is triggered in sequence, resulting in slower overall air bag deployment with less initial force. During a higher speed collision, both or more inflators operate simultaneously for full immediate inflation in order to correspond with the greater impact force.</td></tr>
<tr><td colspan="3">Accident investigation uses:
This data element indicates the level of deployment for the driver’s multi-stage air bag at the time surrounding the triggering event.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
Yes or No</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>N/A / YesNo</td><td colspan="2">-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

Data element number: 39	**Data element name:** Frontal air bag deployment, nth stage disposal, front passenger, y/n	**Acronyms:** ADLp	**Condition:** IR
Description/operation/filter class: Where there are multi-stage passenger air bags, this data element provides the indication of the air bag deployment level. The deployment level is preprogrammed into the ECM based upon predetermined, authorized scenarios. During a slow-speed collision, the dual-stage inflator system for the passenger side air bag is triggered in sequence, resulting in slower overall air bag deployment with less initial force. During a higher speed collision, both inflators operate simultaneously for full immediate inflation in order to correspond with the greater impact force.			
Accident investigation uses: This data element indicates the level of deployment for the passenger's multi-stage air bag at the time surrounding the triggering event.		**Possible alternative/additional uses:**	
Data definition/sign convention/coordinate system: **Special cases:**			
Resolution: Yes or No		**Accuracy:** N/A	
Sampling frequency and range: Phase dependant			

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / YesNo	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks:	

Data element number: 40	**Data element name:** Side air bag deployment, time to deploy, driver	**Acronyms:** ADdST	**Condition:** IR

Description/operation/filter class:
The EDR records the time at which the ECM commanded the driver's side air bag to activate in accordance with preprogrammed deployment scenarios.

Accident investigation uses: To identify when the driver's side air bag activated or cycled during the crash.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 ms	**Accuracy:** ± 2 ms

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 0-250 ms	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 41</td><td colspan="3">Data element name:
Side air bag deployment, time to deploy, front passenger</td><td>Acronyms:
PSAB</td><td>Condition:
IR</td></tr>
<tr><td colspan="6">Description/operation/filter class:
The EDR records the time at which the ECM commanded the passenger’s side air bag initially to activate in accordance with preprogrammed deployment scenarios.</td></tr>
<tr><td colspan="3">Accident investigation uses:
To identify when the passenger’s side air bag activated or cycled during the crash.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
1 ms</td><td colspan="3">Accuracy:
± 2 ms</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>N/A / 0-250 ms</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

Data element number: 42	Data element name: Side curtain/tube air bag deployment, time to deploy, driver side	Acronyms: SCDS	Condition: IR

Description/operation/filter class:
The EDR records the time at which the ECM commanded the driver's side curtain / tube air bag initially to activate in accordance with preprogrammed deployment scenarios.

Accident investigation uses: To identify when the driver's side curtain / tube air bag activated or cycled during the crash.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 ms	**Accuracy:** ± 2 ms

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 0-250 ms	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

<table>
<tr><td>Data element number: 43</td><td colspan="3">Data element name:
Side curtain/tube air bag deployment, time to deploy, front passenger side</td><td>Acronyms:
SCPS</td><td>Condition:
IR</td></tr>
<tr><td colspan="6">Description/operation/filter class:
The EDR records the time at which the ECM commanded the passenger’s side curtain / tube air bag initially to activate in accordance with preprogrammed deployment scenarios.</td></tr>
<tr><td colspan="3">Accident investigation uses:
To identify when the passenger’s side curtain / tube air bag activated or cycled during the crash.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
1 ms</td><td colspan="3">Accuracy:
± 2 ms</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>N/A / 0-250 ms</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:</td></tr>
</table>

Data element number: 44	**Data element name:** Pretensioner deployment, time to fire, driver	**Acronyms:** ABTFEP	**Condition:** IR

Description/operation/filter class:
The EDR records the time at which the restraint system's ECM authorized the driver's pretensioner to activate or cycle. If the driver seat belt is in use the pretensioner is commanded to activate. If the seat belt is not engaged then the pretensioner will not be activated. The manufacturer of the restraint system programs the command instructions into the ECM based upon authorized scenarios.

Accident investigation uses: Provides the time history from the initial triggering event to the time that the driver's seat belt pretensioner device activated.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 ms	**Accuracy:** ± 2 ms

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 0-250 ms	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

Data element number: 45	**Data element name:** Pretensioner deployment, time to fire, front passenger	**Acronyms:** ABTPF	**Condition:** IR

Description/operation/filter class:
The EDR records the time at which the restraint system's ECM authorized the passenger's pretensioner to activate or cycle. If the passenger seat belt is in use, the pretensioner is commanded to activate. If the seat belt is not engaged, then the pretensioner will not be activated. The amount of elapsed time of this evaluation and activation, if any, is recorded in the MVEDR. The manufacturer of the restraint system programs the command instructions into the ECM based upon authorized scenarios.

Accident investigation uses: Provides the time history from the initial triggering event to the time that the passenger's pretensioner device was initially commanded to activate or cycled.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: 1 ms	**Accuracy:** ± 2 ms

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	N/A / 0-250 ms	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

Data element number: 46	**Data element name:** Complete file recorded (Yes/No)	**Acronyms:** CFR	**Condition:** IR
Description/operation/filter class: States whether the file was recorded complete or the recording procedure was interrupted out of certain reasons.			

Accident investigation uses: Shows the level of integrity of the recorded event data set.	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: -	**Accuracy:** -

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	-	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks:	

<table>
<tr><td>Data element number: 47</td><td>Data element name:
Satelite Position Information</td><td>Acronyms:
GPSP</td><td>Condition:
IR</td></tr>
<tr><td colspan="4">Description/operation/filter class:
Provides the absolute vehicle position of the vehicle. Will be useful for detailed reconstruction, including path over ground. Will also support infrastructure safety evaluation and statistical hazard identification.</td></tr>
<tr><td colspan="2">Accident investigation uses:
Provides absolute vehicle position. Allows track of vehicle path over ground surrounding the event.</td><td colspan="2">Possible alternative/additional uses:
Supports infrastructure safety evaluation and statistical hazard identification.</td></tr>
<tr><td colspan="2">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Resolution:
Full NMEA dataset</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="4">Sampling frequency and range: Phase dependant</td></tr>
</table>

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
1Hz	1Hz	-	1Hz	1Hz

<table>
<tr><td>Data format:</td><td>Discussion/references:
None</td></tr>
<tr><td>Data element according J1939-71:</td><td>Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="2">Remarks:
Raw data will be recorded</td></tr>
</table>

6.2.2.3 Data Elements not required for European Event Data Recording

The following 22 data elements have been identified as not required for European event data recording. Their properties have therefore not been defined. They are quoted here only as a matter of reference to the NHTSA list:

<table>
<tr><td>Data element number:</td><td colspan="2">Data element name:
Seat track position switch, foremost, status, driver</td><td>Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="5">Description/operation/filter class:</td></tr>
<tr><td colspan="3">Accident investigation uses:</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
Yes or No</td><td colspan="2">Accuracy:
N/A</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>N/A / YesNo</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:
'Seat track position switch, foremost, status, driver' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number:</td><td colspan="2">Data element name:
Seat track position switch, foremost, status, front passenger</td><td>Acronyms:
DsP</td><td>Condition:
NR</td></tr>
<tr><td colspan="6">Description/operation/filter class:
The signal reports the position of the drivers seat at the time surrounding the triggering event using a sensor that is installed in the driver’s seat track.
Any movement of the driver’s seat is recorded via the displacement transducer and associated electrical signal conditioning circuit that is located in the seat track.</td></tr>
<tr><td colspan="3">Accident investigation uses:
The position of the driver’s seat within the seat track can be determined at the time surrounding the triggering event.</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
Yes or No</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td>N/A / YesNo</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
'Seat track position switch, foremost, status, front passenger' is not a required element in the VERONICA data element list.</td></tr>
</table>

Data element number:	Data element name: Occupant size classification, driver	Acronyms:	Condition: NR

Description/operation/filter class:
The occupant recognition (OR) system will record the presence of the driver seat occupant by size using strain gages and/or weight sensors located in the lower seat frame assembly. This data element will work with several other data elements, such as seat position, passenger restraint, air bag deployment, that are all elements of the overall safety restraint system. The information will be automatically entered into the restraint system ECM for reference at the time surrounding the triggering event

Accident investigation uses:	Possible alternative/additional uses:
This data system will recognize and record the driver seat occupant by size	
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: Yes or No	**Accuracy:** N/A

Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	N/A / YesNo	-	-	-

Data format:	Discussion/references: None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:
'Occupant size classification, driver' is not a required element in the VERONICA data element list.

Data element number:	**Data element name:** Occupant size classification, front passenger	**Acronyms:** SPOC	**Condition:** NR

Description/operation/filter class:

The occupant recognition (OR) system will record the presence of the passenger seat occupant by size

using strain gages and/or weight sensors located in the lower seat frame assembly. This data element will work with several other data elements, such as seat position, passenger restraint, air bag deployment, that are all elements of the overall safety restraint system.

The information will be automatically entered into the restraint system ECM for reference at the time surrounding the triggering event

Accident investigation uses:	**Possible alternative/additional uses:**
This data system will recognize and record the passenger seat occupant by size	This data system will recognize and record the status of the child's car seat that may be placed in the front passenger seat. This is a special circumstance that occurs in vehicles that accommodate one passenger.
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: Yes or No	**Accuracy:** N/A

Sampling frequency and range: Phase dependant

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	N/A / YesNo	-	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**

Remarks:

'Occupant size classification, front passenger' is not a required element in the VERONICA data element list.

<table>
<tr><td colspan="2">Data element number:</td><td colspan="3">Data element name:
Occupant position classification, driver</td><td colspan="2">Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="8">Description/operation/filter class:</td></tr>
<tr><td colspan="5">Accident investigation uses:</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="5">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="5">Resolution:
Yes or No</td><td colspan="3">Accuracy:
N/A</td></tr>
<tr><td colspan="8">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td colspan="2">N/A / YesNo</td><td colspan="2">-</td><td colspan="2">-</td><td>-</td></tr>
<tr><td colspan="4">Data format:</td><td colspan="4">Discussion/references:
None</td></tr>
<tr><td colspan="4">Data element according J1939-71:</td><td colspan="4">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="8">Remarks:
'Occupant position classification, driver' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="3">Data element number:</td><td colspan="3">Data element name:
Occupant position classification, front passenger</td><td colspan="2">Acronyms:</td><td colspan="2">Condition:
NR</td></tr>
<tr><td colspan="10">Description/operation/filter class:</td></tr>
<tr><td colspan="6">Accident investigation uses:</td><td colspan="4">Possible alternative/additional uses:</td></tr>
<tr><td colspan="6">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="4"></td></tr>
<tr><td colspan="6">Resolution:
Yes or No</td><td colspan="4">Accuracy:
N/A</td></tr>
<tr><td colspan="10">Sampling frequency and range: Phase dependant</td></tr>
<tr><td colspan="2">Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td colspan="2">-</td><td colspan="2">N/A / YesNo</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="5">Data format:</td><td colspan="5">Discussion/references:
None</td></tr>
<tr><td colspan="5">Data element according J1939-71:</td><td colspan="5">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="10">Remarks:
'Occupant position classification, front passenger' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td>Data element number:</td><td colspan="3">Data element name:
Ignition</td><td colspan="2">Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="7">Description/operation/filter class:</td></tr>
<tr><td colspan="4">Accident investigation uses:</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="4">Resolution:
-</td><td colspan="3">Accuracy:
-</td></tr>
<tr><td colspan="7">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="4">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="4">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="7">Remarks:
Ignition is not required because we have the ignition cycles
Systems are not working without ignition on
'Ignition' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number:</td><td colspan="4">Data element name:
Temperature</td><td colspan="2">Acronyms:</td><td colspan="2">Condition:
NR</td></tr>
<tr><td colspan="10">Description/operation/filter class:</td></tr>
<tr><td colspan="5">Accident investigation uses:</td><td colspan="5">Possible alternative/additional uses:</td></tr>
<tr><td colspan="5">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="5"></td></tr>
<tr><td colspan="5">Resolution:
-</td><td colspan="5">Accuracy:
-</td></tr>
<tr><td colspan="10">Sampling frequency and range: Phase dependant</td></tr>
<tr><td colspan="2">Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="5">Data format:</td><td colspan="5">Discussion/references:
None</td></tr>
<tr><td colspan="5">Data element according J1939-71:</td><td colspan="5">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="10">Remarks:
'Temperature' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td>Data element number:</td><td colspan="3">Data element name:
Magnetic field</td><td>Acronyms:</td><td colspan="2">Condition:
NR</td></tr>
<tr><td colspan="7">Description/operation/filter class:</td></tr>
<tr><td colspan="4">Accident investigation uses:</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="4">Resolution:
-</td><td colspan="3">Accuracy:
-</td></tr>
<tr><td colspan="7">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="4">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="4">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="7">Remarks:
'Magnetic field' is not a required element in the VERONICA data element list.</td></tr>
</table>

Data element number:	**Data element name:** Internal temperature	**Acronyms:**	**Condition:** NR
Description/operation/filter class:			
Accident investigation uses:		**Possible alternative/additional uses:**	
Data definition/sign convention/coordinate system: **Special cases:**			
Resolution: -		**Accuracy:** -	
Sampling frequency and range: Phase dependant			

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	-	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks: 'Internal temperature' is not a required element in the VERONICA data element list.	

<table>
<tr><td>Data element number:</td><td colspan="4">Data element name:
Humidity</td><td colspan="2">Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="8">Description/operation/filter class:</td></tr>
<tr><td colspan="5">Accident investigation uses:</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="5">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="5">Resolution:
-</td><td colspan="3">Accuracy:
-</td></tr>
<tr><td colspan="8">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="5">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="5">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="8">Remarks:
'Humidity' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number:</td><td colspan="3">Data element name:
Pressure</td><td colspan="2">Acronyms:</td><td colspan="2">Condition:
NR</td></tr>
<tr><td colspan="9">Description/operation/filter class:</td></tr>
<tr><td colspan="5">Accident investigation uses:</td><td colspan="4">Possible alternative/additional uses:</td></tr>
<tr><td colspan="5">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="4"></td></tr>
<tr><td colspan="5">Resolution:
-</td><td colspan="4">Accuracy:
-</td></tr>
<tr><td colspan="9">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="6">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="6">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="9">Remarks:
'Pressure' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td>Data element number:</td><td colspan="3">Data element name:
Images outside</td><td>Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="6">Description/operation/filter class:</td></tr>
<tr><td colspan="4">Accident investigation uses:</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="4">Resolution:
-</td><td colspan="2">Accuracy:
-</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
'Images outside' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number:</td><td colspan="2">Data element name:
Images inside</td><td>Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="6">Description/operation/filter class:</td></tr>
<tr><td colspan="4">Accident investigation uses:</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="4">Resolution:
-</td><td colspan="2">Accuracy:
-</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
'Images inside' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="2">Data element number:</td><td colspan="4">Data element name:
Sound inside</td><td colspan="2">Acronyms:</td><td colspan="2">Condition:
NR</td></tr>
<tr><td colspan="10">Description/operation/filter class:</td></tr>
<tr><td colspan="6">Accident investigation uses:</td><td colspan="4">Possible alternative/additional uses:</td></tr>
<tr><td colspan="6">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="4"></td></tr>
<tr><td colspan="6">Resolution:
-</td><td colspan="4">Accuracy:
-</td></tr>
<tr><td colspan="10">Sampling frequency and range: Phase dependant</td></tr>
<tr><td colspan="2">Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="5">Data format:</td><td colspan="5">Discussion/references:
None</td></tr>
<tr><td colspan="5">Data element according J1939-71:</td><td colspan="5">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="10">Remarks:
'Sound inside' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td>Data element number:</td><td colspan="3">Data element name:
Maximum Δv, lateral</td><td>Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="6">Description/operation/filter class:</td></tr>
<tr><td colspan="3">Accident investigation uses:</td><td colspan="3">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="3"></td></tr>
<tr><td colspan="3">Resolution:
-</td><td colspan="3">Accuracy:
-</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
Can be calculated from acceleration values.
'Maximum Δv, lateral' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td>Data element number:</td><td colspan="2">Data element name:
Maximum Δv, longitudinal</td><td>Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="5">Description/operation/filter class:</td></tr>
<tr><td colspan="3">Accident investigation uses:</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="3">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="3">Resolution:
-</td><td colspan="2">Accuracy:
-</td></tr>
<tr><td colspan="5">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td>Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="2">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="5">Remarks:
Can be calculated from acceleration values.
'Maximum Δv, longitudinal' is not a required element in the VERONICA data element list.</td></tr>
</table>

<table>
<tr><td colspan="3">Data element number:</td><td colspan="3">Data element name:
Time, maximum Δv, lateral</td><td colspan="2">Acronyms:</td><td colspan="2">Condition:
NR</td></tr>
<tr><td colspan="10">Description/operation/filter class:</td></tr>
<tr><td colspan="5">Accident investigation uses:</td><td colspan="5">Possible alternative/additional uses:</td></tr>
<tr><td colspan="5">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="5"></td></tr>
<tr><td colspan="5">Resolution:
-</td><td colspan="5">Accuracy:
-</td></tr>
<tr><td colspan="10">Sampling frequency and range: Phase dependant</td></tr>
<tr><td colspan="2">Early pre-crash</td><td colspan="2">Near pre-crash</td><td colspan="2">Crash</td><td colspan="2">Near post-crash</td><td colspan="2">Far post-crash</td></tr>
<tr><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="4">Data format:</td><td colspan="6">Discussion/references:
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<tr><td colspan="4">Data element according J1939-71:</td><td colspan="6">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="10">Remarks:
Not necessary
'Time, maximum Δv, lateral' is not a required element in the VERONICA data element list.</td></tr>
</table>

Data element number:	**Data element name:** Time, maximum Δv, longitudinal	**Acronyms:**	**Condition:** NR	
Description/operation/filter class:				
Accident investigation uses:		**Possible alternative/additional uses:**		
Data definition/sign convention/coordinate system: **Special cases:**				
Resolution: -		**Accuracy:** -		
Sampling frequency and range: Phase dependant				
Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	-	-	-
Data format:		**Discussion/references:** None		
Data element according J1939-71:		**Parameter Group Number acc. J1939-71:**		
Remarks: Not necessary 'Time, maximum Δv, longitudinal' is not a required element in the VERONICA data element list.				

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Time, maximum Δv, resultant</td><td>Acronyms:</td><td>Condition:
NR</td></tr>
<tr><td colspan="6">Description/operation/filter class:</td></tr>
<tr><td colspan="4">Accident investigation uses:</td><td colspan="2">Possible alternative/additional uses:</td></tr>
<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="4">Resolution:
-</td><td colspan="2">Accuracy:
-</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td>-</td><td>-</td></tr>
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<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
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'Time, maximum Δv, resultant' is not a required element in the VERONICA data element list.</td></tr>
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NR</td></tr>
<tr><td colspan="6">Description/operation/filter class:</td></tr>
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<tr><td colspan="4">Data definition/sign convention/coordinate system:
Special cases:</td><td colspan="2"></td></tr>
<tr><td colspan="4">Resolution:
-</td><td colspan="2">Accuracy:
-</td></tr>
<tr><td colspan="6">Sampling frequency and range: Phase dependant</td></tr>
<tr><td>Early pre-crash</td><td>Near pre-crash</td><td colspan="2">Crash</td><td>Near post-crash</td><td>Far post-crash</td></tr>
<tr><td>-</td><td>-</td><td colspan="2">-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Data format:</td><td colspan="3">Discussion/references:
None</td></tr>
<tr><td colspan="3">Data element according J1939-71:</td><td colspan="3">Parameter Group Number acc. J1939-71:</td></tr>
<tr><td colspan="6">Remarks:
Can be calculated from acceleration values.
'Δv, lateral' is not a required element in the VERONICA data element list.</td></tr>
</table>

Data element number:	**Data element name:** Δv, longitudinal	**Acronyms:**	**Condition:** NR
Description/operation/filter class:			

Accident investigation uses:	**Possible alternative/additional uses:**
Data definition/sign convention/coordinate system: **Special cases:**	
Resolution: -	**Accuracy:** -
Sampling frequency and range: Phase dependant	

Early pre-crash	**Near pre-crash**	**Crash**	**Near post-crash**	**Far post-crash**
-	-	-	-	-

Data format:	**Discussion/references:** None
Data element according J1939-71:	**Parameter Group Number acc. J1939-71:**
Remarks: Can be calculated from acceleration values. 'Δv, longitudinal' is not a required element in the VERONICA data element list.	

6.2.3 Common physical properties for input interfaces

This deliverable aims at the definition of the physical properties and the protocol of the input interfaces for CVs as an efficient industrial standard.

6.2.3.1 Relevance of EDR system approaches

We assume that there will be different system approaches for the realisation of EDR functionalities in a vehicle. The different solutions will vary from fully integrated EDR, a so called embedded system approach to retro-fit solutions and a so called stand alone system. There will also be only partly integrated systems driven by the vehicle manufacturers who will add lacking EDR input signals or functionalities by adding necessary components to the body network already existing.

6.2.3.2 Need for a definition of a standardised interface

Embedded and partly integrated systems will be not concerned by interface standardisation, because the manufacturers will have to accomplish the whole EDR functionality within their vehicle network and will have to safeguard the compliance with the EDR legislation.

The need for the definition of an input interface is relevant only for stand alone systems. This is to introduce a safeguard that after-market solutions can rely on identical electronic interfaces that connect to the vehicle. This will also be an opportunity for low volume vehicle manufacturers, for example specialist car manufacturers as well as for retrofit device suppliers, to comply with the future EDR legislation.

6.2.3.3 CAN bus networks

From the current point of view we have and will have in future vehicles an increasingly complex mesh of distributed functionalities. All of these are connected by CAN-Bus Systems or future FlexRay systems. The architecture of these systems is very different for vehicle classes and is dependent on the strategy of the manufacturer. Most new architectures are based on three and more buses. In principle we will find most of the signals needed for EDR input on these buses, but there is no single common access point where the necessary information.can be collected.

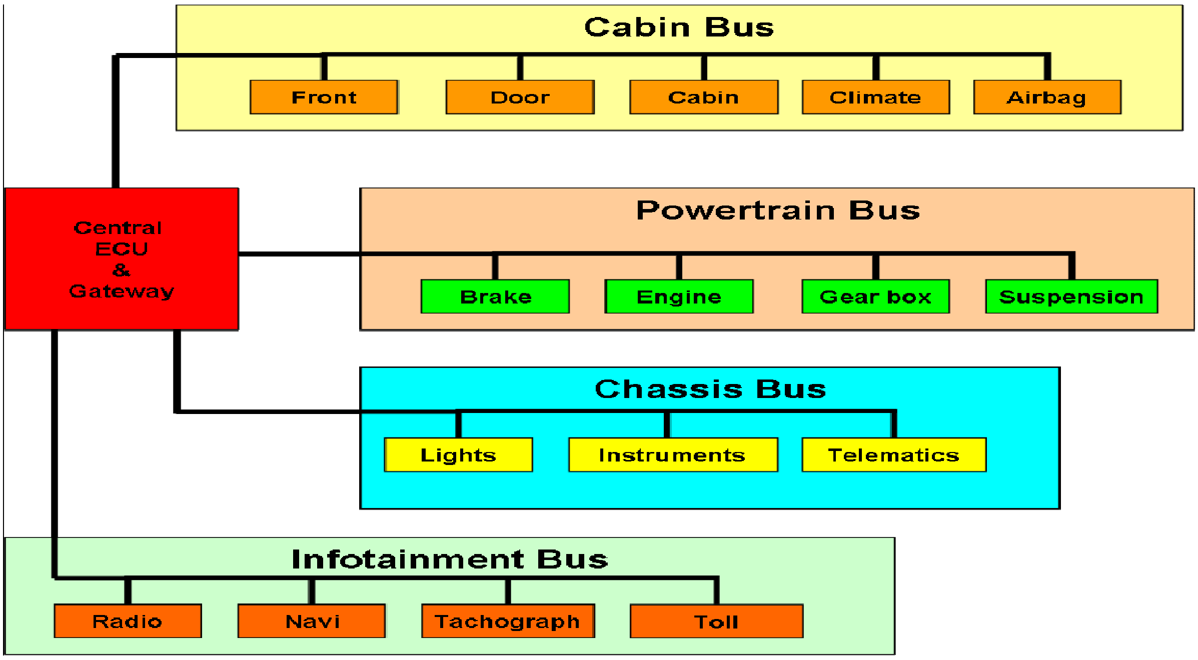

Fig. 34: Example for a CAN network in a vehicle

The example above shows a typical CAN network; if we want to have the necessary signals for EDR we need to have information from all shown buses. Therefore the requirement will be that the vehicle has to be equipped with a common access point where all necessary information is gated into a standardised format. A lot of today's commercial vehicles are equipped with networks according to or very similar to the SAE J1939-71 standard. We propose signal standardisation according to the definitions of this standard. Lacking data elements will be added by a change request to the responsible standardisation body.

For rare applications it would also be possible to have an interface from hard wired body network to the standardised EDR interface via an adaptor. This unit would transform the electronic input signals, for example pulses from a speed sensor or high and low levels from lights, indicators etc., into CAN Messages. This will be a possibility for all vehicle manufacturers, but in fact it will also open the door for small volume producers and after market solutions.

6.2.3.4 Matching between data elements and signals standardised and not yet standardised

For the following consideration which refer to the necessary input signals we have to differentiate between the data elements recorded in an EDR and the necessary input signals for the EDR provided by the vehicle and its network. If the EDR system is connected e.g. to terminal 15, (ignition), according to the electrical level it would gain the status information and count the ignition cycle, but the ignition cycle itself is not an input signal. Nevertheless all data elements are shown in the next tables for completeness.

The minimum required data elements together with existing standards are listed below:

Data Element	Conditio	Element # in J1939-71	Parameter Group Number	Remarks
Longitudinal acceleration	R	SPN 1810	PGN 61449	
Lateral acceleration	R	SPN 1809	PGN 61449	
Longitudinal acceleration (IP)	R	tbd	tbd	
Lateral acceleration (IP)	R	tbd	tbd	
v (Speed, vehicle indicated)	R	SPN 1624	PGN 65132	DTCO
Engine throttle, percent full	R	SPN 51	PGN 65266	SPN 91 also poss.
Brake status (Service brake, on, off)	R	SPN 521	PGN 61441	
Ignition cycle, crash	R	N/A	N/A	
Ignition cycle, download	R	N/A	N/A	
Frontal air bag warning lamp, on, off	R	tbd	tbd	
Frontal air bag deployment, time to deploy/first stage, driver	R	tbd	tbd	
Frontal air bag deployment, time to deploy/first stage, front passenger	R	tbd	tbd	
Multi-event, number of events (1, 2)	R	no input	-	-
Time from event 1 to 2	R	no input	-	-
Indicator	R	SPN 2876	PGN 64972	
Horn	R	tbd	tbd	
Main beam	R	SPN 2872	PGN 64972	
Dip beam	R	SPN 2874	PGN 64972	high beam
Parking lights	R	SPN 2872	PGN 64972	
Yaw angle	R	SPN 1808		yaw rate
Trigger Date Time	R	SPN 959 to 964	PGN 65254	Time provided by DTCO
Download Date Time	R	SPN 959 to 964	PGN 65254	Time provided by DTCO

Fig. 35: Tabled minimum required data elements by existing standards

In the table above we have 12 signals defined by the SAE Standard J1939-71, while 6 signals have to be additionally defined, of which 5 signals apply to data elements concerning the airbag control system which is not standard equipment for commercial vehicles. Data elements marked with N/A do not need these input signals.

A second class of data elements categorised as "if equipped" (IE) and "if recorded" (IR) is shown in the following table:

Data Element	Conditio	Element # in J1939-71	Parameter Group Number	Remarks
Normal acceleration	IR	tbd	tbd	
Normal acceleration (IP)	IR	tbd	tbd	
Vehicle roll angle***	IE	SPN 3319	PGN 61459	
Engine speed, in r/min	IR	SPN 190	PGN 61444	eng. speed dep.
ABS activity	IE	SPN 563	PGN 61441	
Stability control, on, off, engaged	IE	SPN 561/562	PGN 61441	Engine/Brake
Steering wheel angle (steering input)	IR	SPN 3683	PGN 61469	
Safety belt status, front passenger	IE	tbd	tbd	
Frontal air bag suppression switch status, front passenger	IR	tbd	tbd	
Frontal air bag deployment, time to nth stage, driver	IE	tbd	tbd	
Frontal air bag deployment, time to nth stage, front passenger	IE	tbd	tbd	
Frontal air bag deployment, nth stage disposal, driver, y/n	IR	tbd	tbd	
Frontal air bag deployment, nth stage disposal, front passenger, y/n	IR	tbd	tbd	
Side air bag deployment, time to deploy, driver	IR	tbd	tbd	
Side air bag deployment, time to deploy, front passenger	IR	tbd	tbd	
Side curtain/tube air bag deployment, time to deploy, driver side	IR	tbd	tbd	
Side curtain/tube air bag deployment, time to deploy, front passenger side	IR	tbd	tbd	
Pretensioner deployment, time to fire, driver	IR	tbd	tbd	
Pretensioner deployment, time to fire, front passenger	IR	tbd	tbd	
Seat track position switch, foremost, status, driver	IR	tbd	tbd	
Seat track position switch, foremost, status, front passenger	IR	tbd	tbd	
Occupant size classification, driver	IR	tbd	tbd	
Occupant size classification, front passenger	IR	tbd	tbd	
Occupant position classification, driver	IR	tbd	tbd	
Occupant position classification, front passenger	IR	tbd	tbd	
Complete file recorded (Yes/No)	IR	-	-	-
cis-gis Horn	IE	tbd	tbd	
blue light	IE	tbd	tbd	
Satelite Position Information	IR	SPN 584/585	PGN 65267	

Fig. 36: Tabled data sets for classification IE (if equipped) and IR (if recorded) and standards

In the table above, the first two input signals for normal acceleration are not standard in any vehicle categories. The next group of standardised signals belongs to the signals usually needed for stability control and anti blocking system. Therefore these signals are usually available in all vehicle categories. Due to the fact that only a small group of commercial vehicles is equipped with air bags and other occupant-safety systems that activated on the basis of vehicle dynamics, there is a big gap between the standardisation expectations and the required Veronica II data elements. There is no legal requirement to install devices'; a situation exacerbated by the limitations placed on 'if recorded' and 'if equipped'.requirements. These input signals could also be included into the change request to the standardisation body, but with lower priority and may be in a further step.

Cis-Gis Horn and blue light are typical for service vehicles and belong to specially equipped cars.

The last table is only a matter of completeness and shows the data elements not needed by Veronica II Project; consequently no standarsized input signal is needed.

Data Element	Conditio	Element # in J1939-71	Parameter Group Number	Remarks
Δv, longitudinal	NR	-	-	-
Maximum Δv, longitudinal	NR	-	-	-
Time, maximum Δv, longitudinal	NR	-	-	-
Δv, lateral	NR	-	-	-
Maximum Δv, lateral	NR	-	-	-
Time, maximum Δv, lateral	NR	-	-	-
Time, maximum Δv, resultant	NR	-	-	-
Safety belt status, driver	NR	SPN 1856	PGN 57344	
Ignition	NR	-	-	-
Temperature	NR	SPN 171	PGN 65269	
Magnetic field	NR	-	-	
Internal temperature	NR	-	-	
Humidity	NR	-	-	
Pressure	NR	-	-	
Images outside	NR	-	-	
Images inside	NR	-	-	
Sound inside	NR	-	-	

Fig. 37: Tabled not-required data elements and standards

6.2.3.5 Conclusion and next steps

A significant amount of the necessary signals for EDR implementation by stand alone units are already standardised by the SAE J1939-71 standard. The other necessary signals will be standardised by a first change request. A more difficult task for the vehicle manufacturers will be to develop a common interface that incorporates all necessary signals.

A problem may occur regarding the data transfer capacity on the concerning network and the gates between the several CAN buses. Nevertheless it is unreasonable that future standardisation initiatives rely only on traditional hard-wired access to status signals and have no access to existent information such as vehicle dynamics

6.2.4 Data Security

6.2.4.1 Introduction

This report describes IT security requirements for the future EDR. The analysis of these requirements is based on a simple logical model of such a device and the assumed threats to its data and functions.

The report first discusses some basic design issues for an EDR with respect to its security functions. It then analyses the security threats, discussing specific threats that can be derived from the generic threats against confidentiality, integrity, availability and authenticity. The analysis of these threats leads to recommendations for the security requirements to be implemented in the EDR.

6.2.4.2 Basic Design Issues

This section discusses the basics of the security analysis by describing the EDR model used to identify the threats and vulnerabilities of an EDR device.

6.2.4.2.1 EDR model

All analysis with respect to IT security needs to start from a sound model that is sufficiently complex to model real life threats and countermeasures, but is also sufficiently simple to avoid getting distracted by irrelevant implementation detail.

The EDR model used in this analysis assumes a device that may be either a stand-alone box or integrated within other functions. However, the system must be logically distinct and self-contained in order that it can be protected from interference or tampering by other devices.

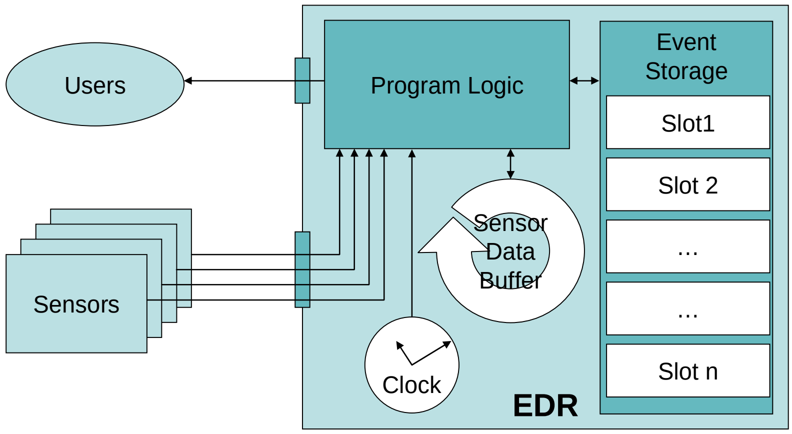

Fig. 38: EDR functional model

As the picture above shows, the EDR will be characterised by three main logical components:

1. The Program Logic reads external input from the sensors, may do some aggregation or other processing and puts the sensor data into the Sensor Data Buffer. When certain ‘trigger’ events are received, the Program Logic selects a slot from the Event Storage and will write buffered data from the Sensor Data Buffer into this slot.

   The program logic will also provide data from the Event Storage to external users requesting to read some or all slots of the Event Storage.
2. The Sensor Data Buffer is a volatile ring buffer which permanently receives data from the sensors. Older data in the buffer is permanently overwritten with newer data. The data cannot be read directly by external users.
3. The Event Storage is a permanent storage area divided into several slots. These slots can be filled with data from the Sensor Data Buffer if a ‘trigger’ event is received.
4. The clock will provide time stamps in a sufficient resolution for the recorded data to be meaningful.

6.2.4.2.2 Simplicity and Openness

When designing security architecture for any system or device experience shows that complexity is a natural enemy of security: complex systems are harder to verify and provide more occasions for failures than simple systems.

This observation is especially valid when it comes to cryptographic functions like digital signatures and data encryption, where adversaries usually do not break the algorithms themselves, but concentrate on other weaknesses in the construction of the software, the distribution of keys, or weaknesses in the associated processes.

One infamous recent example of complexity in the software development process was the Debian SSH packaging failure. In this case, although the software for the secure shell (ssh) software was not faulty itself, a package maintainer that was responsible for putting the software into a distributable package for Debian-based Linux distributions had not included the correct code to generate sufficiently strong pseudo random numbers. This was a requirement for this generation of ssh keys however this omission went undetected for almost two years.

Complexity in the software itself has caused lots of vulnerabilities in recent years. Many of the “buffer overflow” vulnerabilities were found in codes not related to security functions, but running in privileged modes, and therefore allowed, after having being corrupted,to subvert the security functions.

Complexity in the environment is equally ‘evil’ since it introduces as many vulnerabilities as the IT system does itself.

As a generality complexity is likely to introduce new threats, increase the attack surface of a system and increase the likelihood of exploitable bugs merely because there is greater functionality, more codes and additional interfaces.

Similarly, the credo of ‘security by obscurity’ does not work in most real-world environments. If the design of a security device is kept secret this poses an additional hurdle for potential attackers to overcome necessitating reverse-engineering of its inner workings. However, keeping the design obscure also will not provide public scrutiny and limit feedback on potential security issues. History has shown that security by obscurity has had fatal consequences. In WW II the Japanese and German authorities would not accept that their encryption devices could have been deciphered. Decades later, the providers of pay-TV set-top boxes fell into the same trap when their encryption mechanisms were deciphered, and despite this experience, the media industry failed to incorporate proprietary copy protection rendering their DRM mechanisms extremely vulnerable on a regular basis.

Summarising, a simple truth can be used as guidance for the development of security architecture for the EDR:

Simple and open wins[39]

[39] This quote is attributed to Dick Hardt, from his OSCON 2005 keynote speech on Identity 2.0

6.2.4.2.3 Motivation

When considering the threats that need to be countered by the security mechanisms of the EDR, motivation plays a key role in determining the likelihood of attacks.

Given sufficient motivation, someone will try to break your system.

The motivation can have several sources. As a general rule motivation can be described as a possible gain which is considered more desirable by the undertaker than the possible loss associated with the risks.

With respect to the EDR, we can identify the possible gains:

- Evasion of legal prosecution and its associated risks. This is the obvious gain associated with attacking an EDR.
- Financial gain: Money paid by somebody interested in attacking/manipulating an EDR to a person capable of mounting the attack. The amount of money paid will depend on the availability of the skills, the opportunity to successfully mount the attack, and the legal risk (see above) for the customer
- Reputation of breaking a device. Hackers attacking a device may be motivated by the technical challenge of breaking a device and 'owning' it. They may do it like a sport and for the reputation they earn in their peer group, or for political reasons. Think of this like graffiti sprayers or hackers 'defacing' web sites of organisations they don't take offence with.

On the downside, there is the risk associated with the attack

- Being arrested, prosecuted and convicted is a traditional risk linked with the two additional factors of likelihood and damage. The more likely it is that the attack will be noticed and the attacker can be identified, the less likely it is that somebody will take the effort to mount the attack. Likewise, the higher the punishment for being detected, the less likely an attack will be.

It is incorrect to naturally conclude that the motivation to break into a system increases with its proliferation. In the early stages as more systems are installed, the offenders have a greater incentive to find ways of breaking into them. Monetary gain is higher as stolen EDRs become available for potential clients requiring the services of the hackers. Ultimately there are so many stolen systems available that the incentives start to reduce however the reputation damage has already been inflicted by that stage. Similarities can be found with Pay-TV set-top boxes where breaking into these systems started out as an academic exercise; thereafter the proliferation and availability of these boxes quickly lead to an industrialised market for hacking into devices and, by necessity, regular updates for broken content encryption keys.

Another, less obvious conclusion, is that motivation for attackers becomes greater if they can find a generic way to break into devices. If a software bug can be used to break a large number of boxes, this is a considerably more attractive option than laboriously decrypting a key for just one box that requires equivalent effort to break into another box.

6.2.4.2.4 Realistic Goals

Reflecting on these basic thoughts and common IT security experience any security design for the EDR should strive for realistic goals. When introducing new IT-based systems, expectations are often that such systems shall be unbreakable and 100% secure although nobody would expect this from a non-IT system with similar functions. For example, nobody expects that handwritten signatures cannot be forged, and although seals are supposed to be tamper-evident they are often circumvented. People are satisfied that the forging of such evidence has been a sufficiently difficult experience to repel most potential fraudsters, but nobody ever expected that all attacks could be effectively countered. Real-life systems have been working with a much lower margin of security, and people readily accepted that there were always some cases uncovered by the mechanism.

A set of realistic goals that could be applied to an EDR would read as follows:

- **Be at least as secure as the system you had before, and try to be better**

  It is important to recognise that EDRs do not replace an existing system, but add functionality to existing processes. Accident investigation has so far used data collected from the scene of the accident, such as skid marks, dents, scratches etc. This evidence will not be ignored in the future (although skid marks are often not available due to anti-lock brake systems). The EDR data adds to this evidence and will make investigation easier. Since the data collected by the EDR must conform to the other evidence this already provides a high degree of security against forging data.

- **Do not introduce complexity unless forced to do so**

  One well-known example of complex functionality introduced to secure a system has been with digital tachographs. In this case, the obsolete analogue system reached a level of fraud that was not acceptable any more and jeopardised fair competition, fair work conditions and road safety (through driver fatigue).

  The complex security functions did introduce a public key infrastructure (PKI) with smart cards for drivers, workshops and control officers. This infrastructure was possible because all participants were professionals on which such measures could be imposed despite there was a permanent threat of data manipulation throughout the tachograph device's life cycle.

  With an EDR, such complexity would most likely be excessive as the threats of manipulating data are fundamentally different. Events registered by an EDR will be quite seldom throughout the EDR life cycle and cannot be foreseen. As we will see this greatly reduces the circumstances where an attack is necessary and therefore will not justify the complex security measures required for the digital tachograph.

- **Especially, don't introduce complexity for some esoteric scenario**

  This is just a variation of the theme saying that the security benefit must be worth the effort. If complexity introduced will only provide a benefit in very rare occasions then this complexity probably introduces 'more diseases than it provides cures'. For the EDR, this is especially important when looking at the 'window of opportunity' for the manipulation of EDR data.

With these simple rules in mind it is important that there is a review of the threats and attack scenarios for the EDR data throughout the EDR life cycle.

6.2.4.3 Security in the EDR Life Cycle

In this chapter a review is made of a generic model of the EDR life cycle to get a general understanding at which points in the life cycle data could be attacked, disclosed, manipulated, or simply lost. After this introduction a closer examination will be made of the generic security goals of confidentiality, integrity, availability and authenticity and investigate those goals and their threats in detail, which will lead then to the conclusions in the following chapter.

6.2.4.3.1 Life Cycle Overview

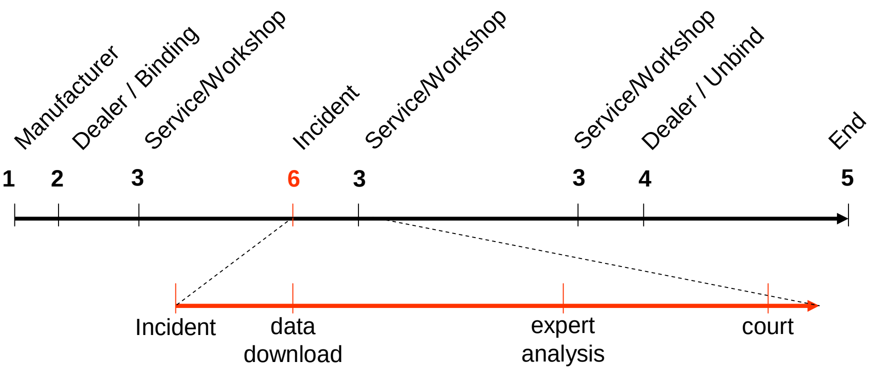

Fig. 39: EDR life cycle

The life cycle presented here has already been defined during the Veronica I project:

- Manufacturer (1): The EDR is manufactured (or reset to its factory defaults). This may include assigning a unique ID for the EDR.
- Dealer / Binding (2): In this phase of the life-cycle, the EDR is bound to a vehicle. This step is similar to the personalisation of a smart card may include entering the vehicle's VIN into the EDR's memory.
- Service / Workshop (3): In this phase, a workshop will get access to the EDR during the normal maintenance cycle and may test the EDR to operate correctly.
- Dealer / Unbind EDR (4): When an EDR is removed from a vehicle, the EDR's binding data will be removed or will be replaced with data of another vehicle it is fitted to (in this case, this phase is similar to stage 2.
- EDR end of life (5): This is the end of the EDR's life cycle with the EDR being decommissioned.
- Accident: Crash or other event (6): This is the most interesting phase in the EDR's life cycle (and the purpose for which it has been built). When an accident occurs, the EDR's data will be required to analyse the accident. Therefore, this phase is shown in some more detail in the picture above (EDR life cycle):
  - o When the accident occurs and the EDR is working correctly, a data record will be written into the EDR's event storage, i.e. its long-term memory.

- To analyse the data, the record concerning the event needs to be downloaded from the device. In our current model, this download can be performed by anybody with physical access to the EDR. It may happen directly at the scene of an accident, or later on in a workshop. The time between the accident and the download may therefore vary between several minutes after the accident until several days. As a special case, hit-and-run accidents may not allow the download of data at all, or only after an extended period of time.
- The data is then passed on to an expert for analysis, who will draw conclusions from the data record associated with the accident and will correlate the EDR data with other evidence gathered for the accident.
- Finally, the EDR data, together with the expert's analysis, may be used in court or by other parties (e.g. insurance companies) to determine the question of guilt and any penalties.

6.2.4.3.2 Generic Threats

This section will briefly introduce the generic threats to the EDR and the EDR data. Security threats can be categorised into several generic categories:

- ***Confidentiality*** is defined as the "property of data that indicates the extent to which these data have not been made available or disclosed to unauthorized individuals, processes, or other entities" ([ISO/IEC 2382-8:1998], 08.01.09)
- ***Integrity*** is defined as the "property of data whose accuracy and consistency are preserved regardless of changes made" (data integrity, [ISO/IEC 2382-8:1998], 08.01.07). For systems (like the EDR itself), integrity means "the quality of a data processing system fulfilling its operational purpose while both preventing unauthorised users from making modifications to or use of resources and preventing authorised users from making improper modifications to or improper use of resources" (system integrity, [ISO/IEC 2382-8:1998], 08.01.27).
- ***Availability*** is defined as the "property of data or of resources being accessible and usable on demand by an authorised entity" ([ISO/IEC 2382-8:1998], 08.01.17)

These definitions are commonly seen as the 'holy trinity' of IT security, encompassing all aspects of security. Nevertheless authenticity is used as an additional category, which is often subsumed under the integrity. In this analysis authenticity is specifically addressed as an explicit category, since it has its own set of threats relevant to the EDR security architecture. EDR data is supposed to be used as evidence in disputes, and therefore its authenticity must be guaranteed to a degree acceptable by courts.

- ***Authenticity*** deals with the origin and genuineness of data: When EDR data is to be used as evidence legal representatives need to be assured that the data originates from the EDR and has not been tampered with.

These generic categories will now be investigated with respect to the specific threats for the EDR and its data throughout the EDR life cycle.

Note that throughout this analysis it is assumed that access to EDR data is only possible for somebody having physical access to the vehicle interior.

6.2.4.3.3 Confidentiality

To address confidentiality,the project worked on the assumption that the data registered by the EDR and available through its interfaces contains no personal data for which privacy concerns need to be addressed.

> **The project team unanimously agreed that no personal driver data shall be registered by the EDR. A certain degree of data privacy issues have to be taken into consideration as data privacy experts need to analyse the data use outside the vehicle.**

With the assumption of the EDR only providing data linked to a specific vehicle, but not to a specific driver, the analysis presented here does not address data privacy concerns. This assumption is bolstered by the desire expressed by the project team to avoid privacy issues by restricting the recorded data to a minimal set of sensor and status data and to record only a time span of about one minute around the accident event.

Apart from the data being recorded, consideration needs to be given to those occasions when people may obtain access to EDR data:

EDR data cannot be easily downloaded by any individual as we assume that downloading data from the EDR requires at least physical access to the vehicle's interior. Therefore, access to the EDR data is always possible (although probably complicated) for the driver or owner. Throughout the EDR life cycle we can determine the following occasions to access data:

- Driver and Owner will always have physical access to the EDR device and will be able to download data. This may represent a problem if the owner can access data that would indicate an accident in which the vehicle was involved and where a driver other than the owner was involved in the accident. For example, a car rental company or transport fleet could regularly access data to find out about accidents by drivers. Even if the rental company does not sue the driver immediately, the company (or even a group of cooperating rental companies) could use the data to keep a ’black list’ of drivers involved in accidents. Since drivers are supposed to notify the company about any accident, accessing the EDR data would only change the situation for those drivers who had not informed the company about the accident. This might be an issue in the case of low-priority accidents. Access to data in this scenario, especially the combination of data with personal data of the driver would most likely require the consent of the driver and would need to be explicitly agreed in the rental contract.

  Although the combination of EDR data with driving records would create data records subject to privacy legislation, and creating ‘black lists’ certainly is a privacy concern, we can also speculate that the knowledge of drivers about the fact that the vehicle owner can access data of possible accidents might have an effect on the driving behaviour, thus helping to increase road safety.

  If car rental companies were to equip their vehicles with EDRs, they would only be willing to do so if they could access the data themselves (either directly or obtain the data otherwise). They would not be inclined to spend the money for an EDR if there was no benefit associated with it.

Comparing EDR data with data obtained by the digital tachograph, we do not see any additional potential for misusing EDR data. A digital tachograph is certainly better suited for driver control than the sparse EDR data. EDR data would be of interest only in vehicles where a tachograph was not present and where somebody would have an interest to connect accident event data to individual drivers.

- Phases 1 and 2: No data available, therefore, no threat of misuse.
- Phase 3: Workshop access during maintenance and service: Although possible, access to the EDR data would not provide any gain to the workshop. Workshops currently keep records of a vehicle's history, mostly for statistics and for customer service. Adding EDR data might provide a more accurate history record, although no significant gain can be envisaged from the limited number of slots and the sparse data collected. Still, access to this data might require the consent of the driver or owner.

  Looking for possible abuses, workshops could sell data to car or insurance companies for statistical purposes, or sell data for marketing purposes. This is already a concern without an EDR. It does not require any additional regulation and does not require action to technically inhibit access, since the workshop is already currently required to treat customer data (which would certainly include EDR data from the customer's vehicle) as confidential.

  We cannot envisage a scenario where the blackmailing of drivers or owners would be a motivation for workshops to download EDR data.
- Phase 4: Similar to workshop access, EDR data might be accessed when the vehicle is sold in order to find out whether the vehicle was involved in accidents or not. In the case of a 'clean' EDR record, this might be interesting for sellers and buyers alike; while EDR records showing some accident might be less interesting for the seller it would certainly have far greater interest to the buyer. However, this scenario does not require any technical security measures.
- Accident: After an accident, it may be possible that neither driver nor owner is capable of controlling physical access to the vehicle. Therefore, an opportunity does exist for third parties to access EDR data from the vehicle, although they may have no rights to access them. Although technically possible, we cannot see any motivation to do this other than to gather evidence. We can compare this situation to by-passers taking photographs. We see no need to technically impede people in accessing such data, since this is no different from a situation without EDRs.

Summarising the confidentiality issues during the EDR life cycle, we cannot see a specific threat in the time period after an accident or when a vehicle is being sold. There may be an issue with controlling drivers as explained in the car rental scenario above, but this needs to be regulated legally rather than technically. Therefore, we do not see a necessity to control read access to data by the EDR itself.

6.2.4.3.4 Integrity

The obvious threat for an EDR is the manipulation of its data. After an accident, a driver or owner of a vehicle may be interested to manipulate EDR data in order to evade prosecution. Manipulation may take several forms, like replacing all data with a forged set of records, changing only selected records, or even changing only selected entries within a record. From an IT security point of view, all of such manipulations involve writing of data into the EDR's event storage and can be treated in the same way. In general, any external change of EDR data in the EDR's event storage is considered to be unauthorised.

However manipulation of data can be classified by the intent of the manipulation:

- An attacker may try to delete data from the EDR's event storage, creating the impression that the accident did not happen at all.
- An attacker may try to overwrite incriminating data in a way that suggests that the EDR or its attached sensors did not function correctly, thus making the EDR data useless for prosecution.
- An attacker may try to consistently change EDR records in a way that suggests that the accident did happen, but the driver did not violate any driving regulations. For example, an attacker might try to change the vehicle speed prior to the accident to a lower value, indicating that the vehicle was being driven within the permitted speed limit. Such manipulations are the most complex ones, because not only the speed data needs to be changed, but also the acceleration/deceleration values, time values (to adapt for the distance travelled and to synchronize with turns etc.) and other data need to be changed consistently.

Forging or manipulating evidence is only possible in certain circumstances during the EDR life cycle:

- First of all, if there is no accident, there is no record, hence no motivation to manipulate it. This excludes any manipulation during any phase of the life cycle before an accident, especially phases 1 and 2.
- We can assume that nobody has advance knowledge of an accident and its exact circumstances, so advance manipulation of data will not happen.
- Therefore, manipulation of data would have to take place after the accident. But once data has been downloaded by an authorised party and has been secured as evidence (most likely by time stamping and digitally signing the downloaded records), manipulation will be almost useless, since any record presented in court (or elsewhere) would have to compete for credibility with the original record already downloaded and introduced into the legal process by the appointed trustworthy expert. Therefore, we can assume that manipulation of EDR data is only a threat during the ‘window of opportunity’ between the accident itself and the point in time where the EDR data is secured as evidence (see figure 3 below).

  We also need to consider the case of a hit-and-run accident, i.e. an accident where data from the EDR will not be downloaded at all, or possibly only after a significant period has elapsed after the accident has occurred. In this case, the vehicle owner/driver will have sufficient time to manipulate the data, since the ‘window of opportunity’ has becomes somewhat larger.
- As already mentioned in the section on confidentiality, there is also a threat of manipulating data before selling the car, similar to manipulations of tachographs. If data can be overwritten or deleted, this would be a likely manipulation to occur.

Apart from the time window, the complexity and cost of a manipulation needs to be compared with the likelihood of detecting the manipulation, which has already been discussed in the Section on Motivation above.

For the cost of the attack, we should assume that a sufficiently large base of installed EDRs will trigger development of sophisticated manipulation tools, especially if such a manipulation can be programmed in software. If we look at today's simulation software and the complex physics engines used in driving simulators, but also in computer games we can safely assume that it will be possible to write programmes capable of reading a set of EDR records and consistently manipulating certain parameters by re-calculating the vehicle behaviour.

As the experience in the open source movement has shown, such manipulation software does not even need to be created with any criminal intent, but may be written by people with a technical interest in the subject, or as a proof of concept to alert users of possible manipulations.

The likelihood of such programs being available certainly rises with the standardisation of EDRs, since programmes would be applicable to a larger installed base. However proprietary solutions will not prevent any attack and most likely will only slow them down. CD/DVD copy protection schemes have been examples of proprietary mechanisms which have been reverse-engineered and broken despite the lack of public information.

With regard to data consistency it is important to note that although EDR data could be manipulated the revised output has be consistent with external evidence such as skid marks, dulls, etc. This will be probably harder to achieve than internal EDR data consistency. It would be even harder if an accident occurs with more than one EDR involved. It may not be possible to get access to the other EDRs, too, for a consistent manipulation of all relevant data sets. In general, once the authorities come across conflicting evidence, the suspicion of manipulation of evidence will be present and the probability of detecting the manipulation increases significantly.

For the deletion of records or pretending a malfunction of the EDR to prevent EDR data from being used as evidence, the situation is no worse than current experience in accidents without EDR evidence. Still, malfunction may be suspicious and, if a manipulation were detected, this would weaken the driver's/owner's position in any prosecution or law suit.

6.2.4.3.5 Availability

Threats to the availability of data are similar to the integrity threats, because they will have similar effects. The lack of availability of EDR data can have different causes:

The EDR or some of the sensors could malfunction. As with any device, wear and tear might lead to malfunctions during the EDR's life time. We expect that the EDR will have self-test routines which will allow the system to check its proper operation and to signal any malfunction to the driver. Whether or not the driver needs to take an action is subject to legal regulations, which may differ locally and based on the vehicle's purpose.

- The EDR could be severely damaged during an accident. Although EDRs will be constructed to operate in a ‘hostile’ environment and to survive a crash, they will probably not withstand fire for an extended time. Nevertheless, the EDR construction and the acceptance testing should ensure that in most cases, the EDR will be able to record crash data and allow downloading the data after an accident.

- People with physical access to the vehicle can sabotage the EDR by cutting the sensor cables or the power supply of the EDR. We expect that such kind of interference with the EDR and its environment will be detectable.
- The EDR event storage may run out of space and not be able to record additional accidents.

As deliberate attacks can be mounted to sabotage the EDR or memory congestion these will be of special interest to security analysts. Both cases are also different to the integrity threats as attacks can take place before an accident.

After an accident, attackers may attempt to destroy the EDR data, which can be done in several ways:

- Data can be overwritten before it is downloaded; this is identical to the threat discussed in the section on integrity.
- EDR (or the event storage part of it) can be removed or destroyed before data is downloaded.

In all cases, i.e. attacking the EDR before or after the accident, we need to ask for the attacker's motivation:

- If an attack is mounted before the accident, the driver would need to know in advance that s/he will behave recklessly and might therefore be in situations that would be recognised by the EDR as an accident and thus being recorded.
- The driver could also wish to prevent the EDR from recording data if it could be used for purposes other than accident investigation, e.g. to evaluate driver performance. In cases where a vehicle is equipped with a digital tachograph, the data provided additionally by the EDR would most likely not present any problem for a driver, at least not in a way that the driver would be tempted to disable the EDR in advance. Therefore, this situation would only be relevant in vehicles without a digital tachograph, where the EDR is the only device to obtain some data. But as the EDR is to record only events with harmful consequences there will be practically no reason to fear behaviour monitoring without such background.
- After an accident, the motivation of a driver/owner is identical to the scenarios described in the section on integrity: The driver may want to get rid of incriminating records by deleting selected or all records or by destroying the EDR altogether.

  When trying to delete records while leaving the EDR intact, an attacker faces several problems:

  - If the record to be deleted is not the last one, the fact that records in between are missing and that the EDR did not function during the accident, but did work properly afterwards, will be hard to argue. Also, if the record would be the last one and an analysis reveals that the EDR still functions properly, this will raise suspicions.
  - The same issue arises if all data is deleted. If the EDR works and tests would show that the EDR correctly records data, this would raise suspicions of a manipulation. Also, if prior data is known to exist (e.g. in

cases where a previous download has been performed), disappearing data would raise suspicion.

- o The only case where deleting records could be successful is in hit-and-run cases where no other circumstantial evidence is available, so that the driver could deny any involvement in an accident.

As we can see from these scenarios, it is probably easier to physically destroy the event storage, rather than trying to delete the data.

In any case, if data is missing from the EDR, investigators are back to the current situation without EDRs.

6.2.4.3.6 Authenticity

When EDR data is to be used in court, it is crucial to prove its authenticity. In our case, this means that a court (or any other authority, for that matter) can be convinced that a data record presented to it can be linked unambiguously to an event and a certain vehicle.

The authenticity needs to be protected during the data's transition from the EDR to the court (see figure 2 for this part of the life cycle):

- accident
- data downloaded
- data analysis
- present evidence in court

The current design of the EDR architecture and data model provides a link between the EDR and the vehicle. However, the EDR itself would not provide a digital signature of any kind to prove that the data originates from this EDR. As the records are not signed by the EDR, everybody in the chain could modify it. Such modifications would be hard to spot if the original record is not integrity-protected.

As explained later in Section 6.2.4.4.3 – ‘Sealing EDR Data’ EDR data needs to be sealed as soon as it is downloaded from the device with the signature of the downloader; this will prevent modifications further down in the chain. It will be crucial to keep the time window between accident and download of the EDR data as small as possible.

Signing the records by the EDR itself cannot be implemented without a significant overhead for a security infrastructure. EDRs, as opposed to digital tachographs, are supposed to work without any human intervention and therefore cannot easily bootstrap their own secure environment. If there is no external intervention (like a driver providing signature keys with a smartcard or typing a password), an attacker can get access to all the information he would need to forge the signature.

There are technical ways to conceal keys in special hardware that is tamperproof, like smartcard chips or TPM modules. However, no hardware available today is ‘fit for purpose’ to operate in the physical environment conditions of a vehicle. Even if such hardware would be available, the issue of a PKI infrastructure would remain.

6.2.4.4 EDR Security Architecture Recommendations

From the analysis of the threats in the previous chapter, we can now deduce some recommendations for an EDR security architecture. These recommendations cover three areas:

- Access to EDR data
- Event priority
- Sealing EDR data

6.2.4.4.1 Access to EDR Data

As the analysis in the section on confidentiality concluded, EDR data is data associated with a vehicle and not with a driver. Privacy concerns exist when EDR data is linked with drivers, but we have not identified any scenario that would provide compelling reasons to have access restrictions imposed by the EDR.

Access to EDR data requires physical access to the vehicle interior and is therefore usually restricted to owners and drivers. Access is also possible when the vehicle is not under the driver/owners control, i.e. when left in the workshop or possibly after an accident. However these scenarios do,not require access restrictions by technical means. Any potential misuse can be addressed by non-technical (i.e. legal regulations).

Therefore we suggest that EDR data is readable for everybody able to connect to the EDR data port. This greatly simplifies the design of the EDR and reduces the complexity of its hardware and software components. There is no need to distinguish between users or roles when a download of data is requested. This will result in a more robust design, since there is no risk of data not being downloadable after an accident because of wrong user authentication.

While reading data should not be restricted we suggest that an EDR implements the following rules for writing data into the EDR event storage:

- EDR event storage data shall not be writeable by any external entity, but only by the EDR itself.
- EDR event storage data shall not be explicitly deleted, except in the case of a full factory reset. It needs to be ensured that such a reset is only possible by authorised workshops.
- EDR event storage data may be overwritten by the EDR itself with newer records, so as to ensure continued operation of the EDR. See the section on “Event Priority” below. One possible implementation is to allow overwriting of old records after a successful download by setting a flag on an event storage slot indicating that overwriting is permitted. Note, however, that such functionality would require the EDR to be able to verify the authority of a request to reset these flags.
- Since the EDR decides which data to transfer to the event storage when sensor values exceed certain threshold values, there should be no easy way to feed the EDR with faked sensor data. For example, an EDR should not have sensor connectors where the original sensors can be unplugged and rogue sensors can be attached. Such a design could be misused to feed

rogue sensor data to the EDR, triggering it to write accident data into an event data slot, thereby “creating” a fake accident.

- If the implementation of the EDR cannot prevent rogue sensor input, some kind of tamper evidence should be sought.

Not providing an interface to write event storage data externally is probably the most important security mechanism to inhibit data manipulation. Although this will prevent the occasional amateur ‘hacker’ from tampering with EDR data, it will not prevent professionals from accessing the storage, possibly by writing directly to the memory chips soldered to the EDR's boards. This should prompt manufacturers to think about impeding such access and providing mechanisms for tamper evidence (like sealing the device in resins or other mechanisms).

Given the constraints for manipulating data (internal consistency, consistency with external evidence, mounting the attack during the window of opportunity between the accident and the data download), such attacks will be quite unlikely. However, if stakes are high and such an attack takes place, evidence is required to verify that the EDR has not been tampered with before downloading the data.

6.2.4.4.2 Event Priority

The introduction of this report presented a model of an EDR with a number of slots to store accident records. The limited number of these slots may, over the lifetime of an EDR, lead to a situation where the EDR runs out of empty slots to store its event data. There are different ways a device can deal with this kind of resource exhaustion:

- Stop registering new records. This is not desirable, as the EDR would be useless for any new accident. In the vast majority of all cases, the last registered major accident will be of interest to investigators, so stopping registering data in favour of old records is simply a bad idea.
- Require a data download to free up the slots. This is a similar situation, because new accidents would not be recorded unless the download took place, and therefore a bad idea for the same reasons, too.
- Overwrite the oldest events: This seems to be the natural approach and will keep the EDR functioning. However, it invites an attack to the event data, depending on the thresholds set in the EDR and the number of available event storage slots: a driver could probably force the accident data of a severe accident to be overwritten by repeatedly running over a speed bump, performing emergency brake manoeuvres, or something similar.

As discussed in the project group, a reasonable approach to continue registering data and prevent important data from being overwritten is to assign priorities to the events and have an algorithm implemented in the EDR which allows to overwrite a low-priority event with a high-priority event, and to overwrite older events of the same priority if no lower-priority event slots are available.

It should be noted that even with such a priority mechanism, an EDR could finally fill up with events of the highest priority. However, the attack described above with artificially creating new events would most likely not work, since high-priority events could not be easily generated.

6.2.4.4.3 Sealing EDR Data

If EDRs cannot provide a reliable proof of authenticity of their data themselves, authenticity and preservation of integrity must be sought by other means.

We suggest that event data downloaded from an EDR is digitally signed by the individual or the organisation performing the download, thus confirming that the download was performed correctly at a certain date and time, from the correct vehicle and device, and sealing the record. Any later change to the record can therefore be detected.

This is a procedure which is similar to today's practice of securing evidence, where authorised personnel collects evidence, inventories it and takes care that the evidence is not changed afterwards.

As figure 3 shows, the ’window of opportunity’ for an attacker to manipulate data is from the time of the accident to the time of the download by a trusted entity (or more precise, an entity that will be trusted by the court, like a witness). Since the court needs to know the extent of this window it is necessary that sealing the EDR data not only involves a digital signature of the downloader on the EDR data but also needs a time stamp to be associated with it. Note that the time stamp is also required for the analysis of the accident, because time stamps provided by the EDR may need to be corrected to compensate the EDR's clock drift.

If the ‘window of opportunity’ for manipulating data is kept to a minimum, attacks dealing with the manipulation of data are hard to mount and most of the time impossible. Nevertheless this ‘window of opportunity’ does exist and must be taken into account by the court. However, the situation is no worse than today where evidence from an accident is not collected immediately. Accident analysts know how to deal with this situation, as do legal authorities.

Since access to the EDR data is not restricted, different parties might get access to the EDR and download the data. This may result in multiple records presented to the court, possibly with conflicting data. This is not regarded this as a problem because differing data for one accident can only mean that one of the parties has tampered with the evidence. It will then be the court's decision on whom to trust in this case having taking all other evidence into account.

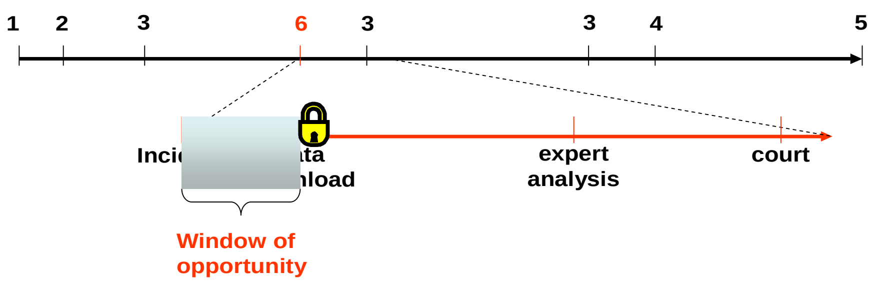

Fig. 40: Window of opportunity

As an additional measure, the sealed data sets might also include information about the software and IT equipment used to perform the download. Using accredited software would increase the confidence of the court that the download procedure itself was correctly performed and that data has not been manipulated during the download process. This is an additional security measure that can be introduced at any time if required by legal experts. It does not need any design change in the EDR.

6.2.4.5 Conclusions and recommendations

6.2.4.5.1 Inherent security measures

- ⇨ **EDRs do not need a highly sophisticated security infrastructure to protect their data for confidentiality, integrity, availability and authenticity. Existing security measures, especially the fact that access to EDR data requires access to the vehicle itself, already provide sufficient means to inhibit most attacks.**

Using a simple design for the EDR security architecture will avoid additional threats to security introduced by complexity.

Upon closer scrutiny, taking into account the motivation of attackers, only a few serious threats need to be considered. All of them can be countered by relatively simple means for the vast majority of the attacks. Since 100% security cannot be achieved anyway, the proposed measures are effective with respect to the security gains and efficient with respect to their implementation cost.

6.2.4.5.2 Trusted party download

The biggest threat to the security of EDR data is manipulation of data during the ‘window of opportunity’ between an accident and the download of the EDR data by a trusted party. Inhibiting external writing to the EDR's event data storage by not exposing external interfaces will reduce attacks to sophisticated attackers, and adding tamper evidence to the physical device will further raise the stakes.

To secure the data once it is outside the vehicle we suggest that event data downloaded from an EDR is digitally signed by an authorised expert or organisation performing the download, thus confirming that the download was performed correctly at a certain date and time, from the correct vehicle and device, and sealing the record. Any later change to the record can therefore be detected.

6.2.4.5.3 Other scenarios

Loss of EDR data due to resource exhaustion of the event data storage can be addressed by assigning priority or severity ratings to events and then scheduling the re-usage of slots in the event data storage based on this classification. The remaining threat of sophisticated attacks to delete date seems acceptable, given the fact that an attacker can always physically destroy the evidence.

6.2.5 Physical Properties for Download Interface

6.2.5.1 Overview

This section describes the findings for defining the interface, the proper method and specification of the protocol for data download from the EDR.

6.2.5.2 General requirements for EDR data download: findings derived from general questionnaire among project partners:

6.2.5.2.1 In detail

- Estimated quantity of data to be downloaded: 1Mbyte maximum.
- Allocated time for downloading: 20s.
- EDR life duration: 15 years at least.
- Number of access during life cycle: 10.
- How to protect data integrity: checksums.
- How to protect data confidentiality: 2 keys TDES, public key process, encrypted data only available to certified authority.
- Audit trail of EDR download session content :
  - Authority downloading and name of person downloading
  - Date, time and place of downloading
  - Identity of downloader and time of downloading permanently recorded on EDR
  - Vehicle Identification Number
  - Persons receiving encrypted or unencrypted data
  - Details of how and when the data was passed to the research database
  - Record of destruction of data where not used
- EDR download interface:
  - EDR location: protected, accessible to enable downloading.
  - EDR in Tachograph: design solution must be neutral.
  - Suitable candidate solutions for EDR data download :
    - Cable communication: ok, but more likely to be tampered with.
    - Wireless: less likely to be reliable in case of severe impact damage.
    - Removable module: easier to comply with trail of evidence requirements, but may have contact problems over time / during crash.
  - Existing standards that should be used: OBD & USB.

6.2.5.2.2 Key-words:

- 1 Mbyte/20s maximum.
- 10 accesses during life cycle.
- Data encryption through download protocol possible?
- Standards: OBD & USB.

6.2.5.3 Discussion of preferred standards for download interfaces:

6.2.5.3.1 On-Board Diagnosis Interface (OBD):

6.2.5.3.1.1 Standards

ISO 27145 World Wide Harmonised OBD: *"This document set includes the communication between the vehicle's OBD systems and test equipment implemented across vehicles within the scope of the WWH-OBD GTR (World Wide Harmonised On-Board Diagnostics Global Technical regulations)."*

Applicability	OSI 7 layers	Implementation of WWH-OBD communication requirements e.g. Emissions-related UDS
Seven layer according to ISO/IEC 7498 and ISO/IEC 10731	Application (layer 7)	ISO/PAS 27145-3 / ISO 14229-1
	Presentation (layer 6)	ISO/PAS 27145-2
	Session (layer 5)	ISO/PAS 27145-4
	Transport (layer 4)	
	Network (layer 3)	
	Data link (layer 2)	
	Physical (layer 1)	

Fig. 41: Enhanced and legislated OBD diagnostic specifications applicable to the OSI layers

ISO 14229-1 Road vehicles – Unified diagnostic services (UDS) – Part 1: Specifications and requirements.

6.2.5.3.1.2 Issues to be considered for identifying Pro & Cons:

- Use of OBD connector already available in vehicles.
- Supply the EDR with the Reader's energy.
- Tools for interfacing PC to OBD exist.
- Need to get an official 11 bits CAN ID if the EDR is integrated in the vehicle network.
- Robustness of the OBD connector.
- Need of specific software to import data in PC.
-

6.2.5.3.2 Universal Serial Bus (USB) Standard:

6.2.5.3.2.1 Standards:

- USB 2.0 norm
  - Mass Storage Class – Bulk-only Transport

6.2.5.3.2.2 Issues to be considered for identifying Pro & Cons:

- Available on all computers. No need of specific software for transferring data.
- No need of a specific cable.
- Not obliged to download data on site.
- USB life expectation.

- Apart from Vehicle Network.
- Unauthorized people are more likely to try to download data.
- Need of an USB transceiver in the EDR.

6.2.5.3.3 Secure Digital Memory Card (SD-Card):

This option has not been examined for the moment, because the challenge would be either a crash resistant and reliable electric contact or to provide an external access to insert the card.

But this solution to download data from the EDR should not be definitely abandoned.

6.2.5.3.4 Pros and cons of the two main candidate solutions:

6.2.5.3.4.1 Items of importance for the two main solutions (OBD & USB)

- Access control should be in the device's physical protection with data download possibility only after opening the device.
- The download solution must be compatible with vehicle architecture.
- Power supply capability from an external device is needed.
- Discussion about the fact that EDR should not be integrated in the vehicle network. The participants reject this requirement.
- Download time: political dimension, against fast download time (still to be discussed).
- Authorisation mechanism can have a big impact on the download time.
- 100kbyte download may be enough (to be confirmed).
- Storage capacity of 10 to 15 events (3 events have to be stored due to the fact that there is a possibility to have multiple events in one accident).
- Security requirements: only to have a read out access, if data not confidential.
- Security discussion: access to data to be secured?
- Impact of tool costs for downloading software and hardware should also be considered.
- Data download: Questionnaire feedback provided two out-coming solutions (OBD or USB), one additional possible solution could be 'no standard', and another could be an 'SD-Card' device. Card devices are not the right media to store the data during the event (in the vehicle); it would be a possible device for download only. USB is not a standard in vehicles, preferred would be an OBD interface.

6.2.5.3.4.2 Conclusions

- OBD solution preferred
- 10-15 events storage capacity

6.2.5.3.5 Vehicle manufacturer's point of view on OBD for downloading EDR data

Four questions were asked to the project partner-OEM regarding the EDR download via OBD. Questions and answers are presented unchanged:

1. Question:

What do you think is the preferred download solution from the vehicle manufacturer's point of view (we understand it is the use of the vehicle OBD connector)?

Answer:

We don't have a preferred solution, however we are keen that the download solution selected by Veronica does not add hardware, or cost to our vehicles. This is why we have suggested the OBD interface as a possible solution; at least for passenger cars / light commercial vehicles (note, light and heavy vehicles have different OBD download interfaces mainly due to different power supply). I have spoken to some of our OBD experts and they have confirmed the OBD connector could provide EDR download functionality as long as the communication protocol etc is correctly defined (ideally by ISO).

The US solution of having a download tool which connects directly to the module in question would also be acceptable for us.

2. Question:

What is your argumentation detailing the reasons why you prefer this solution with respect to other ones?

Answer:

As outlined above we suggested that the OBD connector could be used as it is already available and already performs a similar function (for OBD). It does offer a link into the CAN-BUS and importantly for us would not require additional hardware to be fitted to the vehicle.

As outlined above in North America a tool is used to communicate directly with the relevant modules on the vehicle. This approach would also be acceptable for us in EU.

3. Question:

What is the vehicle manufacturer point of view on the following two issues about the use of the vehicle OBD for downloading the EDR data?

Is there a big risk that in case of an accident, an external reader connected to the OBD connector has no access to the EDR data (depending upon the internal vehicle architecture) ? Why ?

Answer:

Yes, there is a risk. Power, connection, integrity of connector, integrity of CAN-BUS etc are all currently open questions.

Currently we are not able to guarantee the crash performance of the connector, but then again we can not guarantee the crash performance of the CAN either. In North America they get around this problem by attaching the download tool directly to the module in question (Ford download tool supplier is Vetronix). In US we also have to demonstrate the EDR functionality and ability to download data after the legally required frontal and side impact tests.

4. Question:

Would it be a problem for the vehicle manufacturers to allow the electrical power of the parts necessary to EDR data download to be supplied from the external reader connected to the OBD connector ? Why ?

Answer:

Unclear. I'm not aware what the restrictions are regarding powering the vehicle via the OBD connector. It may be better to power the module (and presumably CAN-BUS etc) directly and then read out from the OBD connector, rather than try to power the vehicle via the connector itself. In the US they use an external power supply to power the specific module in question when downloading data.

6.2.6 Power Supply Requirements

This chapter consists in the definition of the power supply requirements and data survivability of relevant sensor data in emergency cases. The results will provide a technical decision basis for the rule making process for European EDR technology. The work within this chapter consists of the following tasks.

6.2.6.1 Assessment of sensor current drain

Basing on the results regarding the defined sampling rate, recording frequency and data structure (defined within VERONICA I and within VERONICA II further above) research has been carried out on the current consumption of state-of-the-art sensors and sensor technologies for the acquisition of the defined accident data. Sensors which are already mounted in series vehicles such as e.g. acceleration sensors for the activation of restraint systems were covered by the research. The target of this task is to quantify both, the quasi-static but also the dynamic energy supply requirements of sensors and EDR system in case of emergency situations.

The output provides a matrix with an overview of series sensor technologies being applied for the acquisition of the defined measurement sizes and the requirements for an emergency power supply in order to ensure the data survivability in case of an accident.

6.2.6.2 Functional categorisation

A wide variety of sensors which are currently used in series vehicles have been analysed with regard to their integration into the vehicle and their overall current consumption. In order to distinguish the different sensor types, a functional categorisation "active safety", "passive safety" and "comfort" has been performed. Within these categories, several domains with approx. 65 different functions have been identified. Each function uses one or more sensor techniques in order to perform.

Categories	Domains		Functions
Active Safety	Driving Dynamics	Longitudinal Dynamics	ABS (Anti Block System)
			TC (Traction Control, ASR)
			EDL (Electric Differential Lock)
			EBR (Engine Braking Regulation)
			BAS (Brake Assist System)
			EBC (Electronic Brakeforce Control)
			Heading Control
		Lateral Dynamics	ESP (Electronic Stability Programm/ Yaw Rate Compensation)
			ARP (Active Rollover Prevention)
			RSC (Roll Stability Control)
			TSC (Trailer Yaw Rate Compensation)
			Roll Angle Compensation
		Vertical Dynamics	ABC (Active Body Control)
			ESS (Electronic Suspension System)
			ACE (Active Cornering Enhancement)
			Automatic Tire Pressure Regulation
			DDS (Deflation Detection System)
			variable Damping
			variable Suspension
	ADAS	Informatory/ Alerting	Electronic Distance Control
			LDW (Lane Departure Warning)
			BSD (Blind Spot Detection)
			CW (Collision Warning)
			Frosted Road Warning
			Driver Monitoring (AMK)
			Curve Speed Assistant
			Overtaking Assistant
			Speed Limit Assistant
		Supporting	Adaptive Light Control
			Dynamic Bending Light (AFS)
			Static Bending Light
			Dynamic Light Distance Control (AFL-Advanced Forward Lighting)
			Adaptive Rear Light (Brake Force Display)
			HLL (Head Lamp Leveling)
		Autonomous	Intelligent ACC
Passive Safety	Occupant Protection	Pre-Crash	Belt Allocation Recognition
			Deformation Path Increasing
			Seats moving in optimal crash position (Anti-Submarining-Seats)
			Pretensioning of Safety Belts
		Post-Crash	Airbag Deployment
			Pedal Adjustment
			Belt Load Limiting
			Moving Steering Column
			Door Unlocking
			Battery Disconnection
			Fuel Feed Stop
Comfort	Driving Dynamics	Longitudinal Dynamics	Hillholder
			HDC (Hill Descent Control)
			Soft Stop Braking
		Lateral Dynamics	Steering Torque Control
			Variable Steering Ratio
			Roll Angle Compensation
		Vertical Dynamics	Level Adjustment
			Skyhook Control
			variable Damping
			variable Suspension
			DDS (Deflation Detection System)
	ADAS	Informatory/ Alerting	Parking Assistant
			Vision Enhancement
			Night Vision
		Supporting	Parking Assistant
			ACC (Adaptive Cruise Control)
		Autonomous	Situation Adaptive ACC
			ACC (Stop&Go)

Fig. 42: Tabled sensor types by functional categories

6.2.6.3 Current consumption

Exemplary sensor current consumptions from a specific sensor manufacturer are shown in the next table. Due to the fact, that the basic physical working principles of most brand's sensors are mostly identical, these current consumptions can be regarded to be representative.

Sensor	Max. current consumption [mA]
Absolute pressure sensor (Variante A)	12.5
Absolute pressure sensor (Variante B)	12.5
Absolute pressure sensor (Variante C)	12
Active engine speed sensor	80
Relative pressure sensor (Variante A)	12.5
Relative pressure sensor (Variante B)	12.5
Yaw rate / accelleration sensor (type A)	70
Yaw rate / accelleration sensor (type B)	130
Engine speed sensor (Hall)	5.5
High-pressure sensor (up to 14 MPa)	15
High-pressure sensor (up to 200 MPa)	15
Inductive engine speed and angle sensor	120
Steering angle sensor (-780° to +780°)	150
Air mass flow sensor (up to 1200 kg/h)	100
NTC temperature sensor (-40°C to +150°C)	1
Surface mechanic accelleration sensor (up to +35g resp.+50g)	14
Passive engine speed sensor	40
Piezo-electric accelleration sensor (up to +35 g)	15
Piezo-electric vibration sensor	15
Lambda sensor	30
Angle sensor (up to 88°)	70

Fig. 43: Tabled sensors by max. current consumption

6.2.6.4 Recommendation on solutions for an EDR emergency power supply

Basing on the requirement specification matrix for an emergency power supply developed above, a recommendation for universally valid potential technical solutions has been worked out. Next to the requirement matrix vehicle powernet architectures and their likely developments until 2010 have been taken into consideration. Three columns for a safe and reliable EDR functionality have been identified:

- Data acquisition prior to a crash
- Complete data acquisition during a crash, and
- Safe data storage and download after a crash

The technical solution to be developed for a fail-safe power supply system must ensure a safe EDR operation in all three cases. The boundary conditions to be considered are:

- As universally valid as possible, for all vehicle manufacturers and brands
- Low costs and complexity
- As few interferences with existing wiring harnesses as possible

Furthermore, the vehicle powernet safety functions and the corresponding reaction towards detected accident cases have an influence on the technical implementation. These safety functions can differ between the vehicle manufacturers.

The relevant data from the pre- and post-crash-phases is provided by approx. 10 different sensors/ECUs, depending on the actual vehicle topology. Fig. XXX from the VERONICA I final report shows the information and data to be acquired.

No	Information Requirements	Importance*	Remarks
1	Collision Speed		Speed at moment of impact
2	Initial Speed		Speed at start of recording a/o braking
3	Speed Profile		Pre- and Post crash
4	dv		?v = Delta-v = Change in velocity due to a collision
5	Longitudinal acceleration (IP)		Impact phase (high resolution)
6	Transverse acceleration (IP)		Impact phase (high resolution)
7	Longitudinal acceleration		Pre- and Post crash (low resolution)
8	Transverse acceleration		Pre- and Post crash (low resolution)
9	Yawing		Pre crash yawing
10	Tracking		Displacement tracking of collision sequence
11	Position		Absolute position
12	Status Signals		Brake light, indicator, lights, blue light, horn ...
13	Trigger Date Time		Relative time, convertible into real time after download
14	User Action		Throttle, brake, steering, horn, clutch ...
15	Monitoring Restraint Systems		Airbags, Seat Belts
16	Monitoring ASD actions		Active Safety Devices (ESP, brake assistant, ABS) go/nogo self-diagnosis for exoneration purposes of manufacturer
17	Monitoring displayed ASD error messages		Messages on faults of ABS Systems etc for exoneration purposes of manufacturer
18	VIN/VRD		Vehicle Identification No/Vehicle Registration No; see table 11
19	Driver-ID		Key, Smart Card, Code ...
20	Monitoring Driver		Visual Monitoring

Table 6 and Fig. 9-12 Veronica I final report

*) high relevance (mainstream)
lesser relevance
low relevance (for specific purposes only)

Fig. 44: Needed and acquired data from pre- and post-crash-phase

Based on this table and assumption the potential for the 'worst-case' accident scenario was investigated; each involved a sensor/ECU-combination that has an average current consumption of approx. 100mA and for whatever reason the battery cable has broken and thus the electrical power steering of the vehicle does not work properly. As a result, an accident occurs. What is remarkable is that in this case a problem with an instable power supply is the cause for an accident, not vice versa!

To ensure a complete data acquisition, a reliable and stable power supply for all involved sensors/ECUs must be guaranteed for the whole pre-crash-phase (30s) and post-crash-phase (10s) plus 120s. Thus, the estimated total energy to be provided is:

E = P_tot * t = U * I_tot * t = 14V * 10 * 100mA * 160s = 2240As = 0.62Ah

This shows, that a buffer device with approx. 1Ah would be fully sufficient to provide the energy needed for data acquisition during the entire pre-/post-crash-phase.

A typical state-of-the-art vehicle CAN-bus network architecture is shown in Fig. XXX. It is easy to see, that the signals to be acquired have origin from different ECUs on different CAN-buses. Thus, a safe and reliable power supply must be guaranteed for all involved sensors/ECUs!

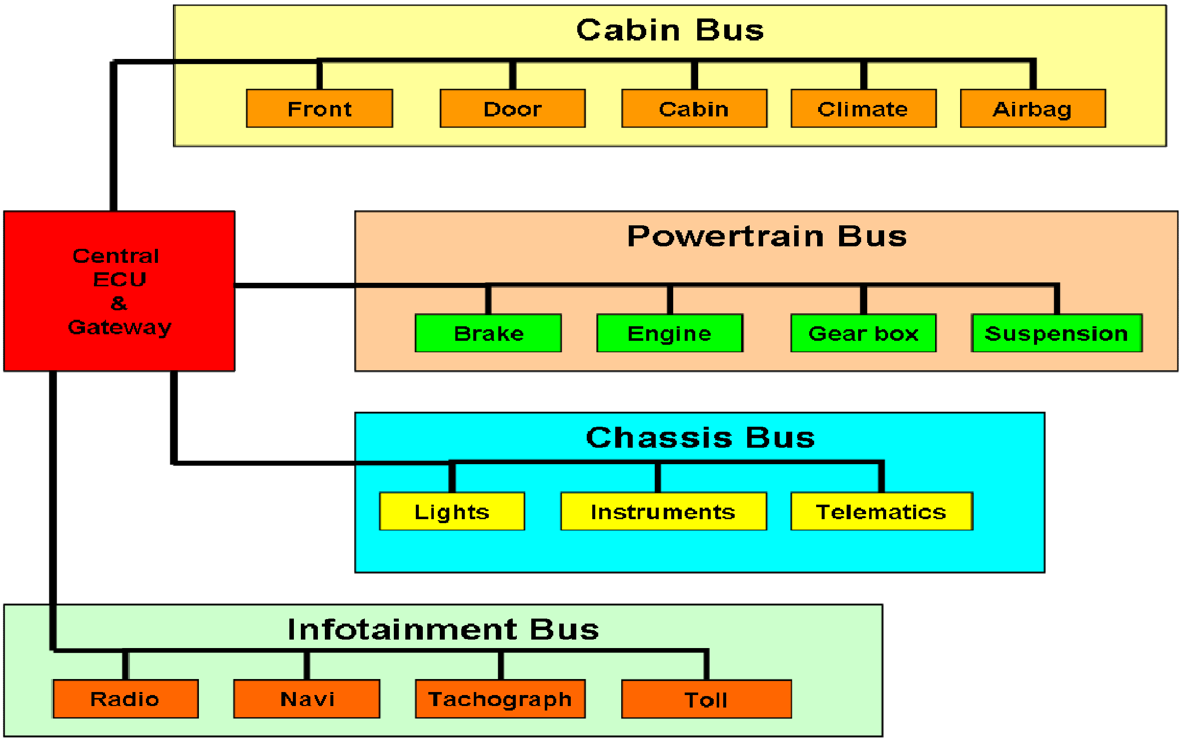

Fig. 45: Typical state-of-the-art vehicle CAN-bus network structure

The outcome of these investigations is shown in Fig. XXX. There, a potential technical solution for a reliable EDR is shown in the form of a dual powernet with backup battery for all involved sensors/ECUs (basic topology). Due to the fact, that the conventional voltage branch is available in conventional as well as in (mild/micro) hybrid vehicles, this suggested topology is basically universally valid. Furthermore, this recommendation shall provide a technical decision basis for the rule making process for European EDR technology.

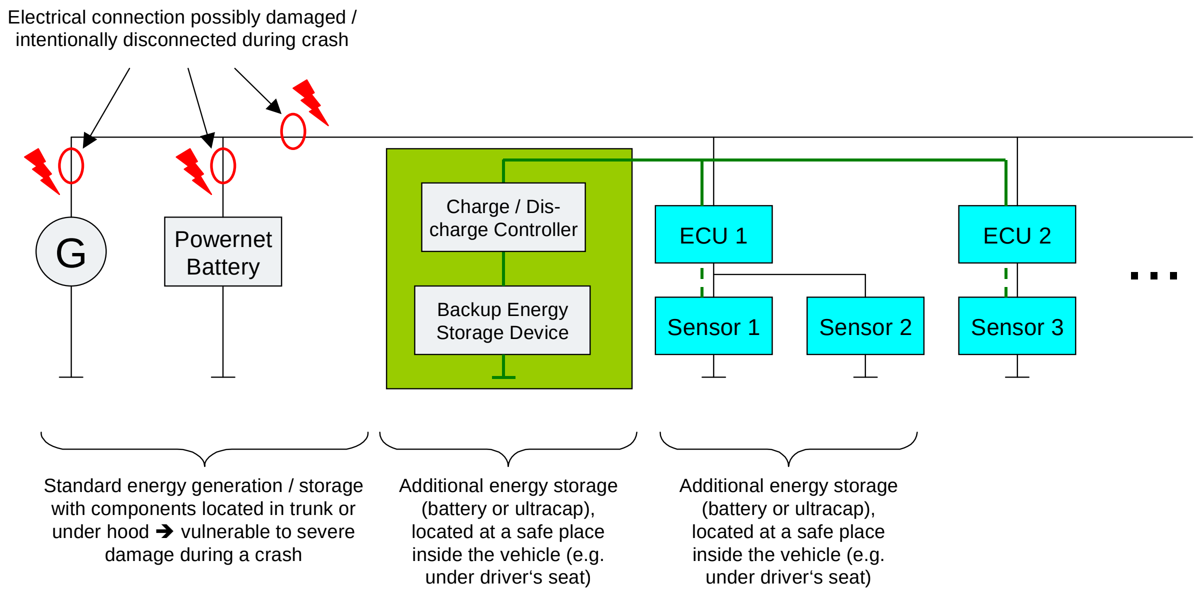

Fig. 46: Potential technical solution for a reliable EDR

6.2.6.5 Derivation of options for technical implementation

In order to be able to realise the developed recommendation, several options for the technical implementation are possible. Options and alternatives for the technical implementation of the energy storage device are as follows (whereas the identified ‘pros and cons’ must be balanced for each implementation!):

Energy storage device:

Battery:

Pro:

- Proven, low-priced technology available
- High energy density (approx. 30-40 Wh/kg)
- Cheap

Con:

- Not suitable for highly dynamic current demands
- Low power density (approx. 300 W/kg)

Ultracap:

Pro:

- High power density (approx. 5000 W/kg)

Con:

- Lower energy density (approx. 4-5 Wh/kg)
- Expensive, relatively novel technology

Fig. XXX shows two different options for the wiring.

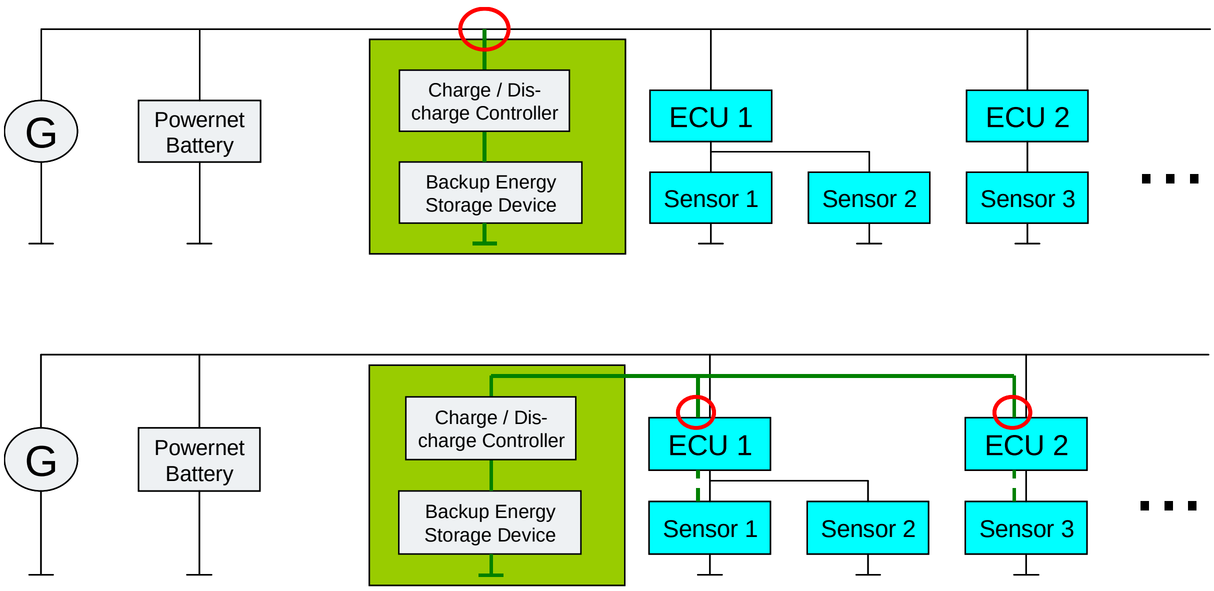

Fig. 47: Possible wiring options

The advantages and disadvantages for each option are:

Central access point:

Pro:

- o Cheap and easy implementation
- o Hardly no additional wiring and modifications of the existing wiring harnesses

Con:

- o Lower reliability and safety (central access point might be damaged during accident)

Local access points:

Pro:

- o High reliability (local power injection)

Con:

- o Higher costs due to more complex wiring
- o Change of existing wiring harness necessary

Regardless of the situation several decisions need to be drawn for the definitive generation of the requirements for the emergency power supply architecture. The identified 'pros and cons' must be balanced for each implementation and once these questions are answered a reliable statement can be given on the powernet architecture. The approach shown above shall be regarded as a basis for the design of a robust powernet architecture, which allows a reliable and high-quality power supply for all sensors during normal vehicle operation and a fail-safe functionality during an emergency phase. It is of course obvious, that the suggested architectures cause some certain additional costs for the low voltage vehicle energy system (e.g. additional batteries or additional switching devices) as well as risks due to the probability of short-circuiting or emitting sparks in case of an accident. Thus, it must be emphasised, that these additional measures do not really justify the effort and the risks which result there from. So the project comes to the conclusion that an emergency power supply will only be an option for a stand alone EDR solution and should not be mandatory for partly or fully integrated EDR systems."

6.2.7 Type approval procedures for Event Data Recorders (EDR)

6.2.7.1 Introduction

EDRs shall collect different data elements from different electronic control units (ECU) in the vehicle. The data collected in EDRs is intended to be used for efficient accident analyses.

EDRs shall be developed as embedded, modular or stand-alone systems.

6.2.7.2 Principal legal possibilities for type approval

This chapter discusses the legal possibilities of getting the type approval certificate for an EDR. The EDR shall be a part of the vehicle where the collected data from the different electronic control units shall be analysed in the case of an accident. The overall objective of EDR implementation is to increase the safety on the road.

6.2.7.2.1 Homologation in road service of the EDR according to Framework Directive 2007/46/EC

The EDR as part of the vehicle shall be possible to become approved for official homologation in road service according to the new Framework Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles:

> *"(14) The main objective of the legislation on the approval of vehicles is to ensure that new vehicles, components and separate technical units put on the market provide a high level of safety and environmental protection. This aim should not be impaired by the fitting of certain parts or equipment after vehicles have been placed on the market or have entered service. Thus, appropriate measures should be taken in order to make sure that parts or equipment which can be fitted to vehicles and which are capable of significantly impairing the functioning of systems that are essential in terms of safety or environmental protection, are subject to a prior control by an approval authority before they are offered for sale. These measures should consist of technical provisions concerning the requirements that those parts or equipment have to comply with"*

This new Framework Directive 2007/46/EC shall apply by the 29 April 2009.

> *2. This Directive does not apply to the type-approval or individual*
>
> *approval of the following vehicles:*
>
> *(a) agricultural or forestry tractors, as defined in Directive*
>
> *2003/37/EC of the European Parliament and of the Council of 26 May 2003 on type-approval of agricultural or forestry tractors, their trailers and interchangeable towed machinery, together with their systems, components and separate technical units (1) and trailers designed and constructed specifically to be towed by them;*
>
> *(b) quadricycles as defined in Directive 2002/24/EC of the European Parliament and of the Council of 18 March 2002 relating to the type-approval of two or three-wheel motor*
>
> *vehicles (2);* (...)

6.2.7.2.2 Homologation of the EDR according to the new Regulation concerning type-approval requirements for the general safety of motor vehicles

On 10 March 2009 there was the first reading in the European Parliament with the view on the adoption of a Regulation concerning type-approval requirements for the general safety of motor vehicles:

> "(*2)* *This Regulation is a new separate Regulation in the context of the Community type-approval procedure under Directive 2007/46/EC.*
>
> *Article 2*
>
> *Sope*
>
> *This Regulation shall apply to vehicles of categories M, N and O and their systems, components and separate technical units as defined in Annex II to Directive 2007/46/EC subject to Articles 5 to 12 of this Regulation*

It is proposed that this new Regulation shall apply on 29. October 2009 [*Proposed introduction date is described in the document COM 2008 (318) dated 2008-05-23]* which is not a prejudice for specific dates of implementation.

The regulation concerning type-approval requirements for the general safety of motor vehicles shall be amended by the functionality of the Event Data Recording similar to the electronic control stability system:

Proposed new article 13

Event Data Recording (EDR)

Vehicles in categories M_1, M_2, M_3 and N_1, N_2 and N_3 shall be equipped with the European Data Event Recording (EDR) meeting the requirements of this Regulation and its implementing measures.

Chapter III

Proposed new article 14

Type-approval of Vehicles, Components and Separate technical Units

(14) Implementation dates of the Requirements for European Data Event Recording on Vehicles in Categories M_1 M_2, M_3 and N_1 N_2, N_3shall be defined.

The question of retrofitting has intentionally been left open. But we do not see any principal problems for defining certain vehicle categories (e.g. M2/M3 + N2/N3) and retrofitting implementation dates which would have to consider the necessary development, type approval and OEM release process times, minimum 36 months.

6.2.7.2.3 Homologation of the EDR according to the new amendment of the COMMISSION Regulation (EEC) No 3821/85 which should be defined as the new annex

The adaptation and amendment of the Commission Regulation (EEC) no 3821/85 is not the way to success. There are different reasons for this:

- From the legislative purpose EDRs have little to do with tachographs although the mechanical ones with the diagram sheets are state of legal practice also for accident analyses.
- The existing Regulation is restricted to the heavy commercial vehicles and busses
- The EDR shall be introduced in more types of vehicles
- The EDR is using different signals from the complete vehicle architecture, not only the signal from the recording equipment
- The existing Commission regulation no. 3821/85 describes only the design features of the recording equipment for getting the type approval.

From the legal point of view the existing Commission Regulation (EEC) No. 3821/85 is not a part of the framework directive 2007/46/EC for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles. This means that if we use the amendment of Commission Regulation (EEC) No. 3821/85 for EDR the regulation is not mandatory for other types of vehicles.

6.2.7.2.4 Summary and recommendation

The new Regulation concerning type-approval requirements for the general safety of motor vehicles has been harmonised at Community level to ensure a high level of road safety and environmental protection throughout the Community. The proposed introduction date of this new regulation should be 29. October 2009. This means that the new Regulation could be amended by the functionality and the test specifications of Event Data Recording (EDR) and also by the vehicle categories to be equipped with EDR.

6.2.7.3 Exposé: Process of getting the type approval for the EDR

6.2.7.3.1 Overview:

There are two possibilities in order to get the type approval for the EDR:

- Single directive of component type approval for the EDR

-Type approval of the EDR together with the vehicle according to the new Regulation concerning type-approval requirements for the general safety of motor vehicles (general vehicle type approval)

6.2.7.3.2 Type approval of the EDR as a single directive

Legal requirements (req.) for this single Directive are described in Council Directive 1999/468/EC and in the framework Directive 2007/46/EC.

The EDR shall be submitted for approval together with any additional fed-in signals. The type approval of the EDR shall include only functional tests which shall be done by the equipment manufacturers. Appendix 1 specifies which tests, as a minimum, must be performed by a Member State authority during the functional tests.

Req. 01: Any modification in software and hardware of the EDR or in the nature of materials used for its manufacture shall, before being used, be notified to the authority which granted type-approval for the EDR. This authority shall confirm to the manufacturer the extension of the type approval, or may require an update or a confirmation of the relevant certificate.

Req. 02: Procedures to upgrade in situ EDR software shall be approved by the authority which granted type approval for the EDR. The software upgrade must not alter nor delete any data from the different electronic control units which shall be collected by the EDR. The data from the different electronic units shall not be destroyed in the case of an accident.

Req. 03: A descriptive plaque shall be affixed to the EDR and shall show the following details:

- name of the manufacturer of the equipment,
- year of manufacture of the equipment,
- approval mark for the equipment type.

6.2.7.3.3 Type approval of the EDR together with the vehicle

The EDR shall be approved together with the vehicle according to the new "Regulation concerning type-approval requirements for the general safety of motor vehicles". The functional tests shall be done by the **vehicle manufacturer**.

Appendix 1 specifies which tests, as a minimum, must be performed by a Member State authority during the functional tests.

This means that the new Regulation concerning type-approval requirements for the general safety of motor vehicles should be amended by the functionality and the test specifications of Event Data Recording (EDR) and also by the equipped vehicle categories.

6.2.7.3.4 Functional tests

Data element number	Data element	Requirements
1	Trigger Date Time	**Resolution:** 1 ms **Accuracy:** +/- 60 s
2	Longitudinal acceleration	**Resolution:** 0.16 m/s² (0.016 g) **Accuracy:** ± 5%
3	Lateral acceleration	**Resolution:** 0.16 m/s² (0.016 g) **Accuracy:** ± 5%
4	Lateral acceleration (IP)	**Resolution:** 1 m/s² (0.1 g) **Accuracy:** ± 5%
5	Longitudinal acceleration (IP)	**Resolution:** 1 m/s² (0.1 g) **Accuracy:** ± 5%
6	v (Speed, vehicle indicated)	**Resolution:** 1 km/h **Accuracy:** ± (3% + 1km/h)
7	Engine throttle, percent full	**Resolution:** 0,01 **Accuracy:** ± 5%
8	Brake status (Service brake, on, off)	**Resolution:** On or Off **Accuracy:** N/A **Remarks:** Time accuracy has to be within (+/- 20msec).
9	Ignition cycle, crash	**Resolution:** 1 cycle **Accuracy:** ± 1 cycle
10	Ignition cycle, download	**Resolution:** 1 cycle **Accuracy:** ± 1 cycle

Data element number	Data element	Requirements
		Remarks: Data set is only provided to the download interface if an event is stored in a slot
11	Frontal air bag warning lamp, on, off	**Resolution:** On or Off **Accuracy:** N/A Functional test should be defined by ISO group.
12	Frontal air bag deployment, time to deploy/first stage, driver	**Resolution:** 1 ms **Accuracy:** ± 2 ms Functional test should be defined by ISO group.
13	Frontal air bag deployment, time to deploy/first stage, front passenger	**Resolution:** 1 ms **Accuracy:** ± 2 ms Functional test should be defined by ISO group.
14	Multi-event, number of events (1, 2, 3)	Functional test should be defined by ISO group.
15	Time from event 1 to 2	**Resolution:** 0.1 s **Accuracy:** 0.s s
16	Horn	**Resolution:** On or Off **Accuracy:** N/A **Remarks:** Time accuracy has to be within (+/- 50msec).
17	Main beam	**Resolution:** On or Off **Accuracy:** N/A:
18	Dip beam / low beam	**Resolution:** On or Off **Accuracy:** N/A **Remarks:** Time accuracy has to be within (+/- 50msec).
19	Parking lights	**Resolution:**

Data element number	Data element	Requirements
		On or Off **Accuracy:** N/A **Remarks:** Time accuracy has to be within (+/- 50msec).
20	Indicator	**Resolution:** On or Off **Accuracy:** N/A **Remarks:** Time accuracy has to be within (+/- 50msec).
21	Yaw rate	**Resolution:** 1°/s **Accuracy:** ± 5°/s
22	Safety belt status, driver	**Resolution:** On or Off **Accuracy:** N/A
23	Download Date Time	**Resolution:** 1 s **Accuracy:** +/- 60 s **Remarks:** Data set is only provided to the download interface if an event is stored in a slot.