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Reasoning for EDR Step 2 topics

Federal Highway Research Institute
24th IWG EDR/DSSAD | Marcus Wisch | BASt

Overview

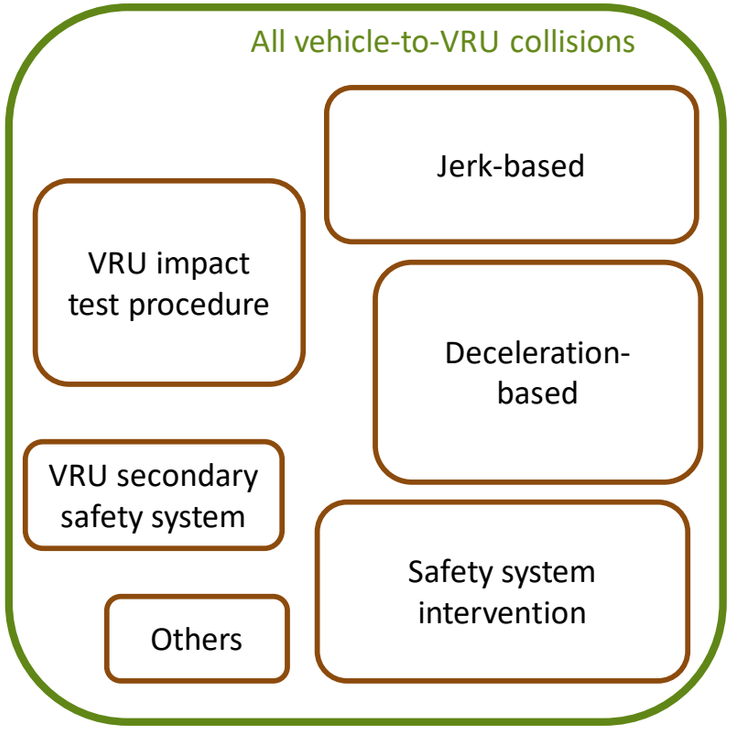
Detailling EDR-DSSAD-IWG-24-09 and SG-EDR-39-08

- Triggering for vehicle-to-vulnerable road user collisions
- Challenge Pre-Crash - Increased recording frequency of pre-crash data on driving dynamics
- ADAS-driver interactions – recording of system warnings

Triggering for vehicle-to-VRU collisions

Different options

- Jerk-based trigger threshold:
  - Final report and statements from BASt's research project are delayed
  - Discussion with industry takes place
  - Further robustness tests are considered
- Deceleration threshold (e.g. 0.8 km/h within 20 ms):
  - Variation of deceleration value and its timing are currently under discussion with independent and industrial experts
- VRU impact test procedure (mechanism to achieve trigger left to manufacturer)
- Safety system intervention (e.g. braking intervention of AEB designed for VRUs)



→ Number of VRU collisions captured by EDR depends on various trigger thresholds (overlapping is expected to unknown extent)

Challenge Pre-Crash

Need for increased recording frequency of pre-crash data on driving dynamics

- Driving dynamics: speed / acceleration / braking:
  - (Legal / research) uncertainty could be caused by misinterpretation of the speedometer speed, because this can be incorrect due to wheel slip by ~10% (“speed, vehicle indicated”)
  - Pre-crash acceleration data is urgently needed to calculate more precisely the collision speed and to correctly assess braking and steering behaviour. Otherwise there is a risk that e.g., pre-collision braking or steering could go undetected.
  - Only integration of the acceleration reliably leads to the actual vehicle speed.

- Recommendation:
  - The vehicle pre-crash acceleration in both, longitudinal and lateral directions, must be recorded with sufficient resolution. A sample rate of at least 10 Hz (better 50 or 100 Hz) is required!
  - Besides, pre-crash steering, braking, yaw angle and yaw angle rate are required at higher frequency than today.

Challenge Pre-Crash – Real Case Example*

Need for increased recording frequency of pre-crash data on driving dynamics

Accident scenario with end positions of the car and bicycle

* Many thanks to Dr. Michael Weyde (independent accident expert) for providing this example case.

Challenge Pre-Crash – Real Case Example

EDR data according to CFR 49 Part 563 (2 Hz sample rate), readout by manufacturer

time	Speed, vehicle indicated km/h	Accelerator pedal %	Engine RPM (combustion engine) rpm	Steering input deg	Service brake activation	ABS activity	Stability control
-5	34	35	1408	-22	off	off	off
-4,5	36	53	1472	-14	off	off	off
-4	38	53	1600	-6	off	off	off
-3,5	41	59	1792	8	off	off	off
-3	45	80	1920	22	off	off	off
-2,5	51	79	2176	20	off	off	off
-2	55	50	2368	14	off	off	off
-1,5	57	31	2432	4	off	off	off
-1	58	0	2432	0	off	off	off
-0,5	58	24	2496	0	off	off	off
0	59	0	2432	-4	off	off	off

time from time zero to algo start (pedestrian) [impact on front bumper]	12 ms
Time from time zero to algo start (front)	algorithm not started
Time from time zero to algo start (side)	algorithm not started
Time from time zero to algo start (rear)	algorithm not started
time from last sample of speed information to Event (t0)	453 ms
Maximum Delta v longitude [km/h]	-4 km/h
time delta V longitude	70 ms
Maximum Delta v lateral [km/h]	0 km/h
time delta V lateral	55 ms

Post-Crash DATA

Zeit [ms]	Delta-V, longitudinal	Delta-V, lateral
0	-1	0
10	-1	0
20	-2	0
30	-2	0
40	-2	0
50	-3	0
60	-3	0
70	-4	0

Last saved speed value: "59 km/h", i.e. around 16.4 m/s

No braking before impact according to pre-crash data in the EDR ("Service brake activation: off")

Impact against the front of the car
Storage algorithm was triggered by a sensor in the front bumper for the active pedestrian protection system

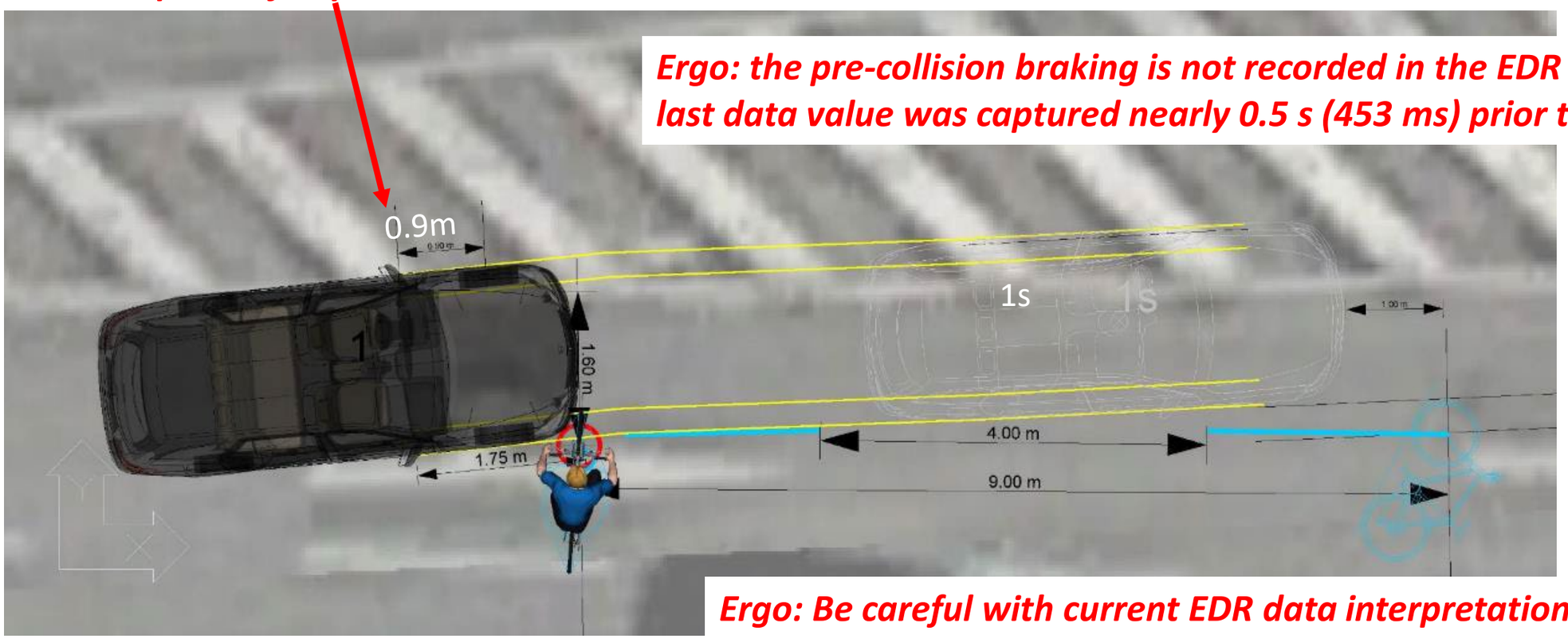
Last speed value recorded ~ 0.5 s (0.453 s) before the impact (t0). Accordingly, the car could have moved around 7 m further without its speed change and / or braking state having been recorded in the EDR.

Delta-V = 4 km/h; thus, we would not have any EDR data at all if the car had not been equipped with an VRU secondary safety system (active pop-up hood)

Challenge Pre-Crash – Real Case Example

Since the car moved less than 1 m from the start of the skid marks to the collision, it may have taken less than 0.1 s from the start of braking to the point of impact.

Ergo: the pre-collision braking is not recorded in the EDR because the last data value was captured nearly 0.5 s (453 ms) prior to the impact



Basic sketch of the impact constellation

Ergo: Be careful with current EDR data interpretation! Higher recording frequency needed and current set of triggers to be expanded!

ADAS-driver interaction

Recording of system warnings (warning cascade) - Context

- In accordance with UN Regulation No. 160 Revision 1, data elements are to be stored regarding, among other things, whether or not an "Automatically commanded steering function (ACSF) category B1 status" was activated and actively steering during the course of the accident.

  These data elements can potentially be used to clarify whether the driver has overridden the system and thus deactivated it (“Off”) or switched it to standby mode (“On but not controlling”). However, information on the ADAS-driver interactions are missing.

- Current research: Knowledge and data is missing about how drivers are reacting to false-positive safety system interventions. Research work (based on driving simulator study) has revealed that none of the subjects could control the presented situation safely. Several questions remain as there is hardly data available from practice (see e.g., https://doi.org/10.3390/s23249785)

- Knowledge about ADAS-driver interactions linked with information from other data elements (e.g. service brake on or off) could be used to track whether or not the warning message was responded to.

Recording of system warnings

Benefits for accident research and requirements for system specifications

- Clarification of the ADAS-driver interactions that took place during the course of an accident
- Knowledge of the objective reaction request time and the driver's reaction time range for executing an (overriding) action
- Findings on (changed) driver behavior with activated ACSF
- Clarification of driver misuse cases (hands-off)

Recording of system warnings

Proposals for data elements

- Time stamp:
  - In the event of an activated ACSF / DCAS* time of appearance of visual, acoustic and / or haptic warning messages:
    - to take over steering / vehicle control, e.g., Direct Control Alert (DCA), or
    - for gripping the steering wheel, e.g., Hands-On-Request (HOR).
  - Time of appearance of visual, acoustic and / or haptic warning messages
    - to look at the road again, e.g., Eyes-on-Request (EOR).

  → Escalation stages should be considered if available

- Time series (recording frequency to be discussed):
  - “Hands-off / hands-on” and “Eyes-off / Eyes-on” in the event of an activated ACSF / DCAS
- Adaptation of the existing ADAS data elements (i.e. adapting "resolution" similar to "AEBS status“)

* Driver Control Assistance System, current work of WP.29, GRVA Task Force ADAS to be considered

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Many thanks.

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