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POTENTIAL SAFETY EFFECTS OF LKA AND AEB SYSTEMS IN FINLAND

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Terms

- **LKA = lane keeping assistance**
- **AEB = automatic emergency braking**
- **ACC = adaptive cruise control**
- **LKA+AEB+ACC=Partially Automated Vehicle (PAV):**
  - Lateral and longitudinal vehicle motion control
  - The driver is always in charge of the driving task.

After the presentation, you (should) know answers on…

- How the potential safety effects of PAV (LKA, AEB and ACC) were studied?
- How many fatal crashes PAV could have avoided?
- Why all of the crashes cannot be avoided by PAV?
- What are the possible paths to further increase the safety potential of PAV?

What and how was studied?

- How many **fatal passenger car crashes** could have been avoided, if conventional vehicles involved in the crash had been **replaced by PAV**?

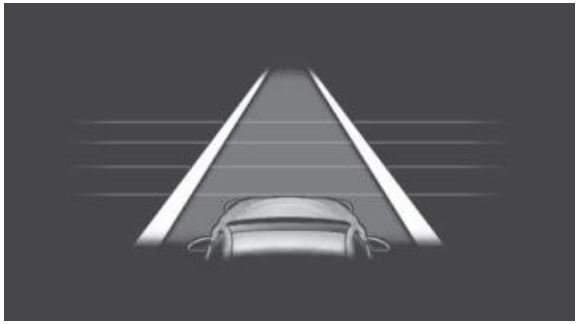
- A crash-by-crash method: each crash is analysed individually

- Data: 506 in-depth investigated crashes in 2014-2016 in Finland
  - Systems' operational conditions were considered in the evaluation

Systems' operational conditions

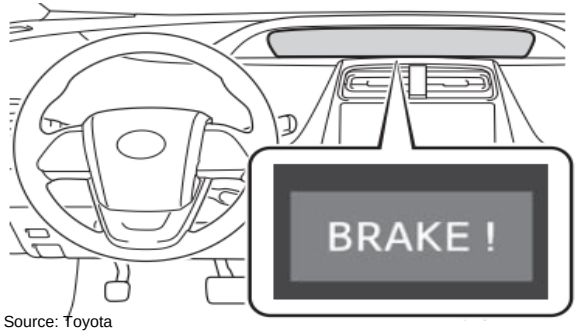
LKA can operate, when..

- Lane markings are visible
- Weather is favourable
- No intended cause, attack of illness or overtaking



AEB can operate, when..

- Vehicle speed ≤ 60 km/h
- Weather is favourable
- No intended cause



Source: Toyota

Example 1

Head-on crash (2 passenger cars)

Visibility of lane markings:

Fully visible lane markings

Weather:

Cloudy

Driver-related risks:

No risks

➢ **LKA prevents the crash!**

Example 2

Single-vehicle crash (passenger car)

Visibility of lane markings:

Lane markings covered by snow

Weather:

Sunny

Driver-related risks:

Driver's attack of illness

➢ **LKA cannot prevent the crash!**

Potential safety effects of PAV

System	Crash type	Prevented crashes by the systems	Prevented fatalities by the systems
LKA	single-vehicle	52 (30%) of 172	57 (30%) of 187
LKA	head-on	47 (24%) of 192	58 (25%) of 228
Total (LKA)		**99 (27%) of 364**	**115 (28%) of 415**
AEB+ACC	rear-end	15 (45%) of 33	15 (42%) of 36
AEB	intersection	19 (36%) of 53	20 (34%) of 58
AEB	pedestrian	13 (45%) of 29	13 (45%) of 29
Total (AEB+ACC)		**47 (41%) of 115**	**48 (39%) of 123**
-	other	0 of 27	0 of 30
Total	**all crashes**	**146 (29%) of 506**	**163 (29%) of 568**

Crash reduction by LKA: 27% of single-vehicle and head-on crashes

- **73%** of crashes could not be avoided – Why?
  - **Driver-related risk in 47%**
    - *Intendedly caused crash*
    - *Driver's attack of illness*
  - **Poor visibility of lane markings in 41%**
    - *Deficiencies in markings*
    - *Covered by snow or ice*
  - **Unfavourable weather in 6%**

Crash reduction by AEB & ACC: 41% of rear-end, intersection and pedestrian crashes

- **59%** of crashes could not be avoided – Why?
  - **Excessive vehicle speed in 44%**
  - **A motorbike in 10%**
  - **Unfavourable weather in 8%**
  - **Intendedly caused crash in 3%**

Assumptions..

- Systems always turned on and 100% penetration rate
- A driver lets the systems operate safely
- Many systems' operational conditions are considered, but not all of them

- The focus is on **maximum safety potential**, which would not be the same as true effectiveness
  - **29% crash reduction = the best possible situation**

How the crash reduction potential could be increased?

From partial automation towards highly automated driving

50% reduction in fatal crashes?

Requirements on infrastructure and vehicles:

- LKA exploits **digital lane markings** (HD maps)
- AEB and ACC with **intelligent speed assistance** (ISA)

With these measures, total crash reduction potential:

29% ➡ 50%

Even higher safety potential?

Requirements on infrastructure and vehicles:

- **System** is responsible of the driving
- Driver cannot **bypass** the system
- **Connected** vehicles and infrastructure

- **Possible new risks may reduce the safety potential!**

Conclusions

- **PAV (e.g. LKA, AEB and ACC) can enhance road safety**
  - Fatal crashes: -29%
- **Driver's role is still important for safety in future**
- **Making these systems mandatory in new vehicles should be considered**
  - A step towards Vision Zero and realising the potential