SECUR

Safety Enhancement through Connected Users on the Road

Deliverable 3.1

Final use cases selection and description

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UTAC

EXECUTIVE SUMMARY

The SECUR project aims to study the potential of connectivity, especially the V2X technology, in improving the safety of different road users. To this end, this project brings together diverse and complementary stakeholders: automotive OEM and Tier1 manufacturers as well as V2X-market-stakeholders and automotive test systems providers.

This report (D3.1) is a SECUR WP3 deliverable. Firstly, it describes the ADAS and V2X literature review performed to summarize the characteristics of the advanced driver assistance systems focusing on their limits, effectiveness and presenting the V2X opportunities. Secondly, the discussions that have led to the SECUR final use cases selection will be synthesised and specified with complementary information. Thirdly, the final use cases list derived from the WP1 use cases will be described in detail.

This deliverable gathered accidentology information coming from WP1 [1] [2], connectivity inputs coming from WP2 [3] [4] and from the work of the WP3.

The link between WP1 accident scenarios and the final SECUR use cases is such that they are derived from at least one WP1 use case, sometimes several, or all. The final SECUR use cases map to the three following Euro NCAP rating schemes: crash avoidance, safe driving, and post-crash safety. However, SECUR considers also crash protection as a V2X safety opportunity, but no study was performed. The final SECUR use cases are listed in the table below (pictograms available in the report):

Table 1 - SECUR final use cases selections

Type		Opponent	WP3 N.#	WP3 Use case
SAFETY	Crash avoidance	Passenger car	#3	**SCP-RD Passenger Car** Crossing passenger car from right side at an intersection.
			#7	**SCP-LD Passenger Car** Crossing passenger car from left side at an intersection.
			#10	**RE-FV Passenger Car** Rear-end braking accident between two passenger cars.
			#12a	**LTAP-OD Passenger Car** Passenger car turning left across the path of another vehicle coming from the opposite
			#01	**Head-On Passenger Car** Face to face impact between two passenger cars.
			#12b	**SCP-OD/LTAP Passenger Car** Passenger car going straight at an intersection and having an accident with a vehicle from the opposite direction turning left across its path.
		Powered two wheeler	#13	**LTAP-OD PTW** Passenger car turning left across the PTW path coming from the opposite direction.
			#015	**SCP-LD PTW** Crossing PTW from left side at an intersection.
		Bicyclist	#2	**SCP-RD Bicyclist** Crossing bicyclist from right side at an intersection.
			#9	**SCP-LD Bicyclist** Crossing bicyclist from left side at an intersection.
		Pedestrian	#4	**SCP-RD Pedestrian** Crossing pedestrian from right side.
			#5	**SCP-LD Pedestrian** Crossing pedestrian from left side.
	Safe driving	All	/	**Local Hazard** A situation, an event, or a state towards in which a vehicle is driving.
		None	/	**Red light violation ego** Ego driver behavior not in line with traffic light status.
		All	/	**Red light violation opponent** Red light violation of another road user (opponent) at an intersection.
	Post-crash safety	All	/	**V2X post-crash warning** The capability of a vehicle to warn the surroundings road users after an accident.
	Crash protection	All	/	**V2X crash protection (safety opportunity)** Fusion of V2X with pre-crash systems to improve the knowledge of the situation and the

To mitigate the crash use cases in Table 1, the following countermeasures where defined based on the ETSI road safety model in C-ITS [5]: “driver information”, “driver awareness”, “driver warning”, “non-safety-critical vehicle action”, “safety-critical vehicle action”, “pre-crash” and “post-crash”. The use cases were linked to these countermeasures in order to summarise which ones are relevant and with what timing. This report also describes a proposed methodology to define when it is relevant to trigger a driver awareness and/or warning alert.

Besides the positive impact advanced driver assistance systems based on on-board sensors have on injury mitigation and accident avoidance, they are now facing technological and physical limits. Most of all with sight obstructions and in poor environment conditions. V2X is one answer to improvements of ADAS. Besides the potential benefit of V2X technology, its readiness also needs to address several challenges before it is widely deployed.

Above all, the main part of this report precisely defines the final selection of the SECUR use cases list considering several aspects: general description, accidentology, connectivity, safety behaviour and SECUR proposal for the V2X integration at Euro NCAP.

Following the SECUR project, remaining studies will need to be done or further developed. Firstly, the subject of HMI and how to provide accurate information, at the right time, to the driver without confusing and disrupting him. And this, while providing the best safety benefits. Secondly, the positioning topic around V2X and the accuracy/confidence requirements for every application or road user should be further studied. Thirdly, the SECUR use cases presented in this report are the main use cases identified based on the number of killed and seriously injured road users using German accident data and a European estimation. However, V2X could bring benefits in many other cases [6]. In addition, more complex use cases will be allowed with the V2X democratisation and improvement.

REVISION HISTORY

Revision	Date	Description, updates and changes	Status
0.1	December 2021	- Creation of the structure of the report and part 2. “Introduction” by Léo CORNEC	Draft
0.2	June 2022	Issuance of 3. “Literature review” part by Tomaz POURCEL, Léo CORNEC and Jorge LORENTE MALLADA.	Draft
0.3	August 2022	First version issuance of the part 4. “Summary of the discussions that have led to the final SECUR use cases selection” and 5. “SECUR final use cases selection” by Léo CORNEC.	Draft
0.4	September 2022	Issuance of the first full document version and document review by Léo CORNEC. Review by all reviewers.	Draft
0.5	October 2022	Addition of 4.3.2 “Driver awareness and warning timing methodology” by Andreas WIENSS. Issuance of the second full document version by Léo CORNEC. Review by all reviewers.	Draft
0.6	November 2022	Contribution of Jorge LORENTE MALLADA with Toyota Motor Europe inputs and studies in part 3. “Literature review”. Issuance of the final document by Léo CORNEC	Draft
1.0	December	Final document	Approved

ABBREVIATIONS

Throughout this report the following terms are used:

ABBREVIATION	DESCRIPTION / DEFINITION
ADAS	Advanced Driver Assistance System/Systems
BC	Bicyclist
CAM	Cooperative Awareness Message
CBFA	Car-to-Bicyclist Farside Adult
CBNA	Car-to-Bicyclist Nearside Adult
CBNAO	Car-to-Bicyclist Nearside Adult Obstructed
CBTA	Car-to-Bicyclist Turning Adult
CCCscp	Car-to-Car Crossing straight crossing path
CCCscpO	Car-to-Car Crossing straight crossing path Obstructed
CCFhol	Car-to-Car Front Head-On Lane change
CCFhos	Car-to-Car Front Head-On Straight
CCFtap	Car-to-Car Front turn-across-path
CCHO	Car-to-Car Head-On
CCRb	Car-to-Car Rear braking
C-ITS	Cooperative Intelligent Transport Systems
CMC	Car-to-Motorcycle Crossing
CMFtap	Car-to-Motorcycle Front turn-across-path
CPFA	Car-to-Pedestrian Farside Adult
CPFAO	Car-to-Pedestrian Farside
CPNA	Car-to-Pedestrian Nearside Adult
CPNAO	Nearside Adult Obstructed
DENM	Decentralized Environmental Notification Message
EEBL	Emergency Electronic Brake Light
EU	European Union
GDV	German Insurance Association
GIDAS	German In-depth Accident Study
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HMI	Human Machine Interface
ICRW	Intersection Collision Risk Warning
IVS	In-Vehicle Signage
KPH	Kilometres per hour
KSI	Killed and severely injured
KTP	Kind of traffic participation
LCRW	Longitudinal Collision Risk Warning
LOS	Line-of-sight
LTA	Left Turn Assist
LTAP-OD	Left Turn Across Path – Opposite Direction (opponent)
M1	Vehicle category 1: Passenger Car
NLOS	Non-line-of-sight

PC	Passenger Car
PD	Pedestrian
PTW	Powered Two-wheeler
RE-FV	Rear-End – Following Vehicle (ego)
RHS	Road Hazard Signalling
SAS	Speed Assist Systems
SB	Steering Board
SCP-LD	Straight Crossing Path (ego) – Left Direction (opponent)
SCP-OD/LTAP	Straight Crossing Path (ego) – Opposite Direction and Left Turn Across Path (opponent)
SCP-RD	Straight Crossing Path (ego) – Right Direction (opponent)
TME	Toyota Motor Europe
TTC	Time To Collision
UC	Use case
UK	United Kingdom
V2I	Vehicle-To-Infrastructure
V2N	Vehicle-To-Network (Uu communication)
V2P	Vehicle-To-Pedestrian
V2V	Vehicle-To-Vehicle
V2VRU	Vehicle-To-VRU
V2X	Vehicle-To-Everything (i.e. vehicle to any type of other station)
VRU	Vulnerable Road User (i.e. Motorcyclist, Bicyclist and pedestrian)
w/wo	With and without
WG	Working Group
WP	Work Package
WP1	SECUR Work Package n°1: Accidentology study
WP2	SECUR Work Package n°2: V2X technology study
WP3	SECUR Work Package n°3: Potential of V2X to improve ADAS performances and final use cases selection
WP4	SECUR Work Package n°4: Development of testing connected targets
WP5	SECUR Work Package n°5: Test and assessment procedures

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1. Introduction

1.1 THE SECUR PROJECT

Through its 2030 roadmap, the European New Car Assessment Programme (Euro NCAP) aims to encourage, by a consumer approach, even more safety on the roads thanks to the use of new inter-vehicle communication solutions. In pursuit of Vision Zero, a functional validation protocol will be developed, and mass-produced vehicles' safety performance will be evaluated.

The SECUR project brings great importance to technological neutrality, while there was at the time a certain rivalry around the V2X (Vehicle-to-Everything) preventing a homogeneous development of connectivity solutions. This pioneering project aims to study the potential of connectivity, especially of V2X technologies, to improve the safety of different road users.

Coordinated by UTAC, the SECUR project expects to push a consistent proposal for V2X testing and assessment protocols to Euro NCAP. To this end, the industrial consortium brings together some twenty international stakeholders, from the entire automotive and V2X ecosystem – automotive OEM, Tier1 manufacturers, V2X-market-stakeholders and automotive test systems providers. They will share knowledge and collaborate through Workshops and Working Groups. First, the most common accident situations on European roads will be studied. Then, the current knowledge on V2X communication systems will be shared and studied. Thereafter, the potential of V2X systems will be studied, either alone or combined with ADAS systems. Finally, multi-technologies connected targets and protocols for evaluating these V2X systems, will be developed.

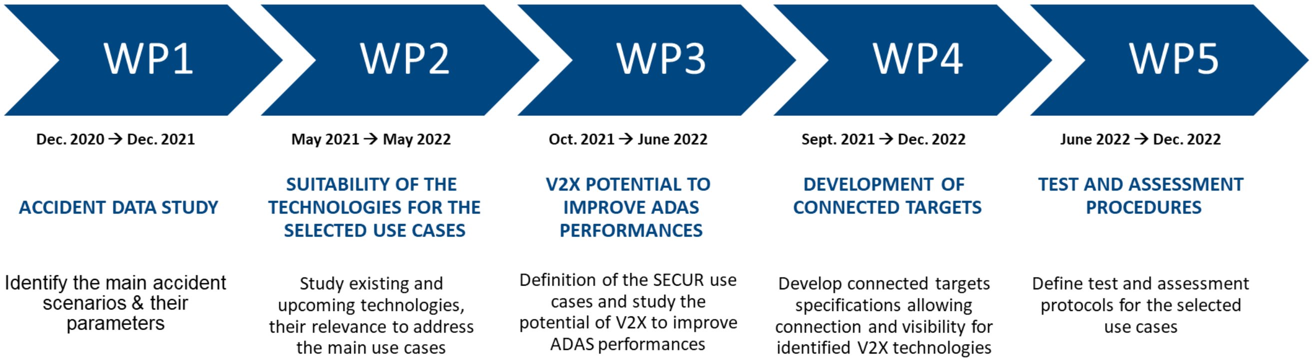


Figure 1 - SECUR project Work Packages

1.2 Objective and scope of the WP3

Vehicles equipped with ADAS have the vision of the surroundings and of what is happening around the car thanks to the information coming from the classical sensors. V2X connectivity is one of the key technologies to bring additional information to the driver and the safety systems beyond the direct line-of-sight.

Since the potential of the connectivity is expected to mitigate dangerous driving situations, SECUR has studied the possibilities of V2X in addition to conventional ADAS and propose realistic approaches on what could be available on the market in a short-term timeframe (2026-2029) based on accidents reduction and injuries mitigation (WP1).

Above all, the main aim of this work package is to precisely define the final selection of the SECUR use cases list considering several aspects: accidentology, test, connectivity, safety behaviour and the SECUR proposal for the V2X integration at Euro NCAP.

1.3 Objective of the deliverable

This report (D3.1) is the key WP3 deliverable. Firstly, it describes the ADAS and V2X literature review performed to summarize the characteristics of ADAS focusing on their limits, effectiveness and presenting the V2X opportunities. Secondly, the discussions that have led to the SECUR final use cases selection will be synthesised and specified with complementary information. Thirdly, the final use cases list derived from the WP1 use cases will be described in detail.

This deliverable gathered accidentology information coming from WP1 [1] [2], connectivity inputs coming from WP2 [3] [4]), and from the work of the WG3.

2. Literature review

The traditional understanding of crash causation supported the perception that the driver or other road user error was the cause of most crashes and was therefore the major issue that needed to be addressed [7]. While road user error is a contributing factor to many crashes, the introduction of ADAS helped to considerably reduce it, [8] but they still let room for improvement. Future vehicle developments create a need to assess relevant accident scenarios not addressed by today's regulations or consumer crash tests. The OSCCAR project [9] analysed the effect of different safety solutions, including ADAS and was considered to validate the SECUR accident scenarios coming from the accidentology (based on frequency and severity).

2.1 OSCCAR PROJECT – 2025 REMAINING ACCIDENTS

2.1.1 INTRODUCTION – OSCCAR PROJECT

The OSCCAR project was funded by the European Commission and part of the H2020 program. It has been coordinated by Virtual Vehicle and has run between June 2018 and May 2021, involving 21 partners from 8 countries (Tier 1 suppliers, OEMs, Research organizations, Universities and 9 international associated partners), with a budget of around 7.5M€.

The general objective of the OSCCAR project was to analyse occupant vehicle safety requirements for highly automated vehicles and define technological developments needed to enable the automotive industry to design and develop new safety systems for advanced safe and comfortable sitting positions. For that, the WP1 focused on applying accident research and future trend analysis to understand future accident scenarios involving passenger cars.

Thereby, considering the influences of driver assistance and active safety technologies, as well as automation, the challenge was to predict which accident types would remain relevant in future years. The accidents expected to remain were then analysed and clustered to provide crash configuration in order to derive requirements for future restraint principles and as starting point of the virtual occupant safety assessment toolchain and homologation scenarios.

The part of OSCCAR evaluation framework relevant to SECUR is related to the analysis of the remaining crash configurations that would remain after the introduction and market penetration of ADAS, the so-called Residual Problem Analysis. The SECUR project considers OSCCAR studies, from the relevant ADAS systems included, up to their impact on accidents reduction and injuries mitigation.

2.1.2 STUDY AND METHODOLOGY

The approach used in OSCCAR project to determine the future accident situation was a two-step approach, a bottom-up approach and a top-down one. The SECUR Project will focus on the bottom-up approach.

The bottom-up approach used consisted in considering the safety technologies such as Driver assistance, active safety-ADAS, passive-, and tertiary safety, including a penetration rate and effectiveness rate for each systemin order to identify the remaining crash configurations. This approach allowed to set an estimation of the future casualty number grouped by accident configuration. The timeframe considered was 2025.

On the contrary, the Top-Down approach assumed that an automated car would not cause accidents which do not comply with traffic rules. This assumption allowed to eliminate all those inherently avoided crashes from the accident statistics.

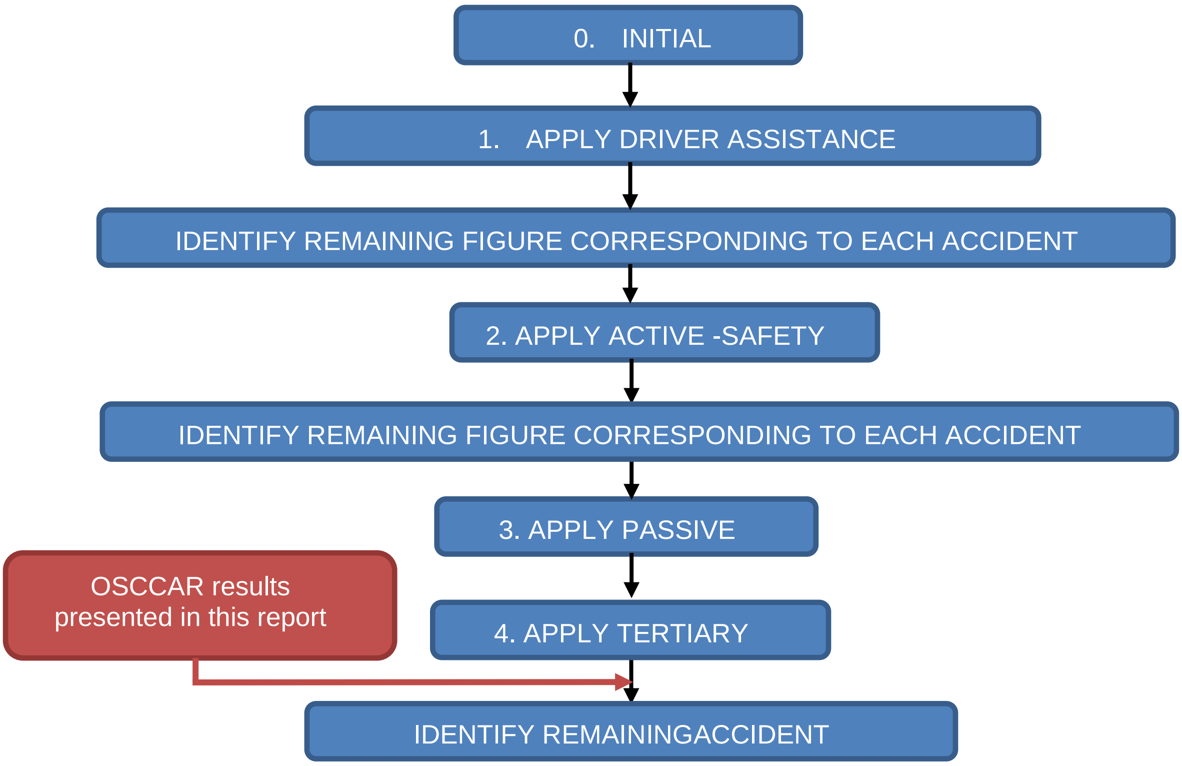


Figure 2 - Schematic view of the Bottom-Up approach followed in OSCCAR D1.1 [9]

The approach was applied both on the French database VOIESUR and the UK databases STATS19 & RAIDS. The remaining casualties obtained after the application of safety technologies were calculated based on the formula shown below and then grouped by crash configuration.

Remaining casualties = Target population × (1- Effectiveness % * Penetration %)

In order to define the target population, filters of the ADAS and safety technologies were applied to each dataset. Additionally, effectiveness and penetration rates had to be considered for each technology for the timeframe given.

TME, who was the partner in charge of this study for OSCCAR D1.1, applied two studies based on the above-mentioned approach, although only Study 1 was part of the OSCCAR work. Based on the interest of SECUR project, TME presented Study 2 results which are shown in this report for the French database analysed.

Study 1: M1 vehicle occupants in car to car or single car accidents (France and UK Data)

Study 2: M1 vehicle occupants and VRU's in car to car, single car, car to VRU accidents (France). 2030 was considered as an additional timeframe

2.1.3 Results

The Residual Problem Analysis was conducted on two different accidents databases: VOIESUR (2011) in France (considering M1 alone, M1-M1 and M1-VRU crashes) and STATS19 + RAIDS (2016) in UK (considering M1 alone and M1-M1 crashes).
Based on the method described in the previous section, the most common accident types after every step could be identified. Considering only Driving Assistance (Step 1), ADAS (Step 2) and Passive Safety (Step 3), the most common remaining accidents in 2025 were identified.

2.1.3.1 France database (overall results)

The Figure 3 below gives us a general overview of the reduction of casualties by 2025 after application of all safety measures:

- Fatalities decreasing by 26%, from 1796 to 1328 in 2025, representing 4% of the casualties instead of 5% nowadays
- Seriously injuries decreasing by 13%, from 10724 to 9290 in 2025, representing 29% of the casualties instead of 30.5% nowadays
- Slight injuries decreasing by 8%, from 22768 to 21010 in 2025, representing 66.5% of the casualties instead of 64.5% nowadays
- The total number of casualties will drop from 35288 to 31628, representing a reduction of 11% of the total casualties on the road for the selected cases

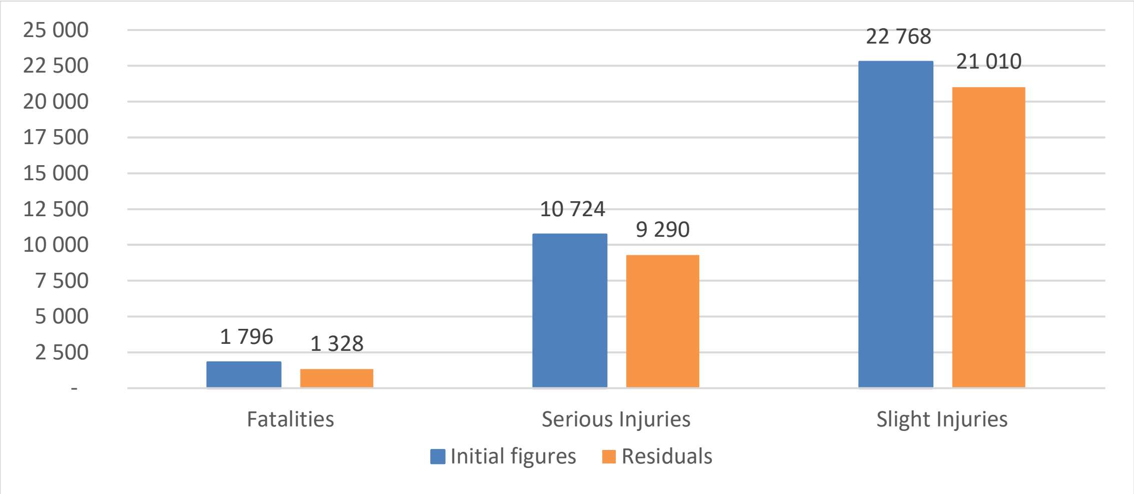


Figure 3 - Casualty reduction by 2025 considering all safety technologies

In Table 2, the most common remaining accidents situations are shown, with the top-5 categories being:

- VRU crossing at junction (18,2% of all injuries in 2025, 17,6% in 2030)
- Front-to-Side collision at intersection (13,9% in 2025, 14,6% 2030)
- Front-to-Front or Side-to-Side collision at intersection (6,4% in 2025, 6,7% in 2030)
- Impact against obstacles (6,2% in 2025, 5,7% in 2030)
- VRU crossing out of junction (4,4% in 2025, 4,3% in 2030)

Table 2 - French accidents configurations database

						2025				2030			
Group and configuration	**Opponents**	**Location**	**Infra.**	**Kind of Accident**	**Image**	**Fatal inj.**	**Serious inj.**	**Slight inj.**	**All injuries**	**Fatal inj.**	**Serious inj.**	**Slight inj.**	**All injuries**
G1 / configuration 1	M1 vs M1		Out of intersection	Rear end		0.6%	0.4%	4.1%	2.8%	0.56%	0.35%	3.60%	2.54%
G2 / configuration 2	M1 vs VRU		Reversing & First impact = Rear	Reverse VRU		0.8%	1.1%	1.2%	1.2%	0.77%	0.98%	1.11%	1.06%
G3 / configuration 14	M1 vs M1		Out of intersection	Side to front		3.9%	1.6%	0.6%	1.0%	3.88%	1.61%	0.58%	1.01%
G3 / configuration 3				Head-on		7.8%	3.6%	1.5%	2.4%	6.83%	3.26%	1.36%	2.12%
G3 / configuration 4				Side to side		0.1%	0.1%	0.5%	0.3%	0.06%	0.10%	0.45%	0.34%
G3 / configuration 5				Rear to front		0.2%	0.0%	0.0%	0.0%	0.26%	0.01%	0.01%	0.02%
G3 / configuration 6 (4)	M1 alone			Frontal, Side or Rear impact against obstacles		17.6%	8.8%	4.2%	6.2%	16.00%	8.13%	4.03%	5.68%
G3 / configuration 7				Frontal, Side or Rear impact against ground-ditch		6.1%	3.3%	1.4%	2.2%	5.71%	2.96%	1.29%	1.95%
G3 / configuration 8				Rollover		4.2%	2.5%	1.7%	2.0%	3.77%	2.36%	1.61%	1.91%
G3 / configuration 993	M1 vs M1			Front to rear or Front to side		0.5%	2.5%	2.0%	2.1%	0.56%	2.61%	2.07%	2.17%
G4 / configuration 10	M1 vs M1		At Intersection	Front to rear		0.5%	1.2%	4.4%	3.3%	0.56%	1.26%	4.44%	3.37%
G4 / configuration 11 (2)				Front to side		6.3%	9.0%	16.6%	13.9%	7.09%	9.47%	17.24%	14.58%
G4 / configuration 9				Frontal vs stationary		0.1%	0.1%	2.2%	1.5%	0.16%	0.14%	2.23%	1.54%
G4 / configuration 994 (3)				Front to front, Side to side, unknown		2.8%	4.2%	7.6%	6.4%	3.07%	4.39%	7.91%	6.70%
G5	M1 vs M1 M1 alone		Going straight on road or at intersection	Frontal mainly and Side		23.4%	24.8%	22.2%	23.1%	25.45%	25.40%	22.97%	23.77%
G6 / configuration 12	M1 vs VRU		No reversing manoeuvre	VRU longitudinal		6.9%	4.5%	3.3%	3.8%	6.88%	4.59%	3.34%	3.84%
G6 / configuration 13 (1)				VRU crossing (@ junction)		7.8%	20.6%	17.7%	18.2%	7.74%	20.19%	16.97%	17.56%
G6 / configuration 15 (5)				VRU crossing (out of junction)		6.5%	4.7%	4.1%	4.4%	6.43%	4.74%	3.96%	4.28%
G6 / configuration 996				Accident with VRU (unknown)		1.7%	4.9%	3.3%	3.7%	2.03%	5.27%	3.43%	3.92%
G7 / configuration 14	M1 vs M1		Out of intersection	Side to front		0.2%	0.0%	0.1%	0.1%	0.26%	0.02%	0.08%	0.07%
G7 / configuration 3				Head-on		1.3%	0.9%	0.4%	0.6%	1.39%	0.86%	0.39%	0.57%
G7 / configuration 4				Side to side		0.2%	0.1%	0.1%	0.1%	0.17%	0.06%	0.08%	0.08%
G7 / configuration 5				Rear to front		0.1%	0.0%	0.0%	0.0%	0.09%	0.02%	0.01%	0.02%
G7 / configuration 6	M1 alone			Frontal, Side or Rear impact against obstacles		0.1%	0.0%	0.0%	0.0%	0.08%	0.01%	0.01%	0.01%
G7 / configuration 8				Rollover		0.0%	0.0%	0.0%	0.0%	0.04%	0.00%	0.00%	0.00%
G7 / configuration 997	M1 vs M1			Front to rear or Front to side		0.1%	1.2%	0.8%	0.9%	0.11%	1.18%	0.83%	0.90%
total						100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

2.1.3.2 UK database (overall results)

The analysis conducted with UK data provided similar results, as it can be seen in Figure 4. The overall reduction of casualties by 2025 would be as follows:

- Fatalities decreasing by 30%, from 1500 to 1000 in 2025
- Seriously injuries decreasing by 21%, from 9600 to 7600 in 2025
- Slight and serious injuries decreasing by 14%, from 101700 to 87500 in 2025

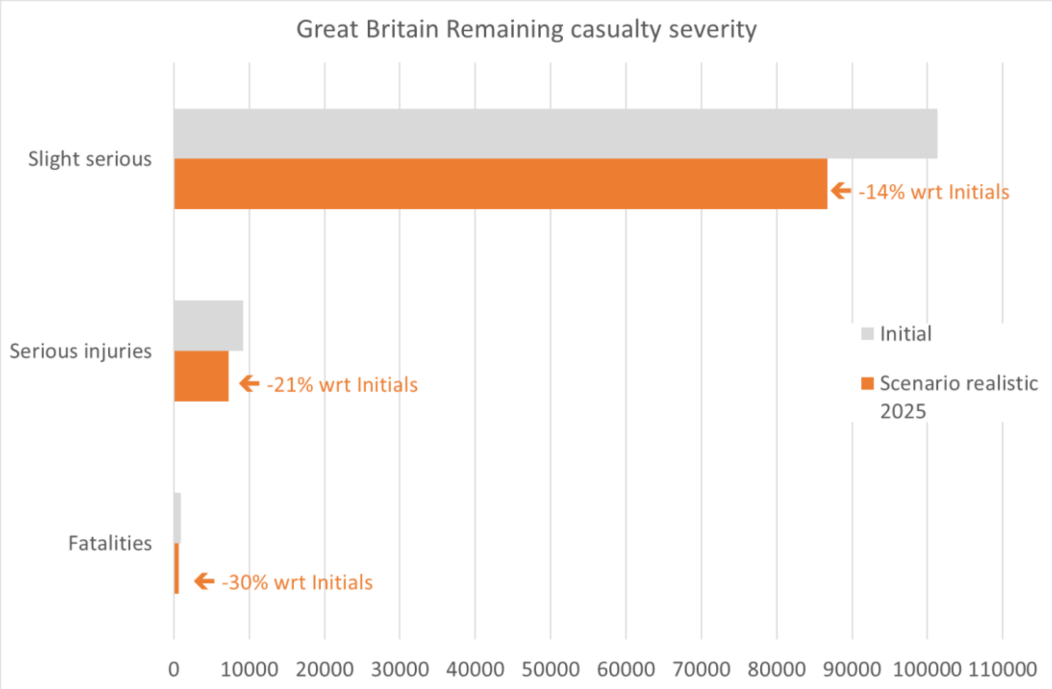


Figure 4 - Evolution of fatalities and injuries considering all safety technologies in Great Britain

From this dataset was highlighted that the most remaining scenarios after considering all safety measures would be:

- Front-to-side collisions (26,5%, mostly slight injuries)
- Rear-end collisions (24,2%, mostly slight injuries)
- Impact against obstacles (20,3%, mostly fatal or severe injuries)
- Front-to-Front collisions (17,8%, mostly fatal or severe injuries)

Table 3 - UK accidents configurations database

Opponent	Collision configuration		2025 figures				2025 figures (%)			
			Fatal injuries	Serious injuries	Slight injuries	All injuries	Fatal injuries	Serious injuries	Slight injuries	All injuries
[illegible]	M1 Front, Rear, Left, Right	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	4	153	1962	14764	16879	22.7%	27.0%	17.0%	17.8%
M1 vs M1	Front-to-Side	1	113	1443	22620	24176	16.7%	19.8%	[illegible]	[illegible]
M1 vs M1	Rear-end	2	16	514	22361	22891	2.4%	7.1%	25.8%	24.2%
M1 vs M1	Side-to-Side		18	316	6683	7017	2.7%	4.3%	7.7%	7.4%
M1 vs M1	Side-to-Back		2	25	593	620	0.3%	0.3%	0.7%	0.7%
M1 vs M1	Reversing		0	5	349	354	0.0%	0.1%	0.4%	0.4%
M1 alone or M1 vs M1	No impact		10	162	1398	1570	1.5%	2.2%	1.6%	1.7%
M1 vs M1	Others		22	187	1796	2005	3.3%	2.6%	2.1%	2.1%
	Total		675	7274	86778	94727	100%	100%	100%	100%

2.1.3.3 General observation

The study of both databases shows that the application of safety systems will have a positive effect in the next decade. Although the trend of casualty reduction at each injury level is similar between both countries, the figures for slight injuries are almost double in UK data. This can be justified by the under-reporting rate of road crash casualties in France, which varies depending on injury severity and

is more relevant for lower injury levels [10].
Both studies show the effect after the application of all safety measures but for SECUR it is especially relevant the contribution of driving assistance and active safety-ADAS safety measures. Such data is available from the study performed by TME for OSCCAR and the results can be seen in Figure 5, Figure 6 and Figure 7 for each casualty level (fatality, severe injury and slight injury).

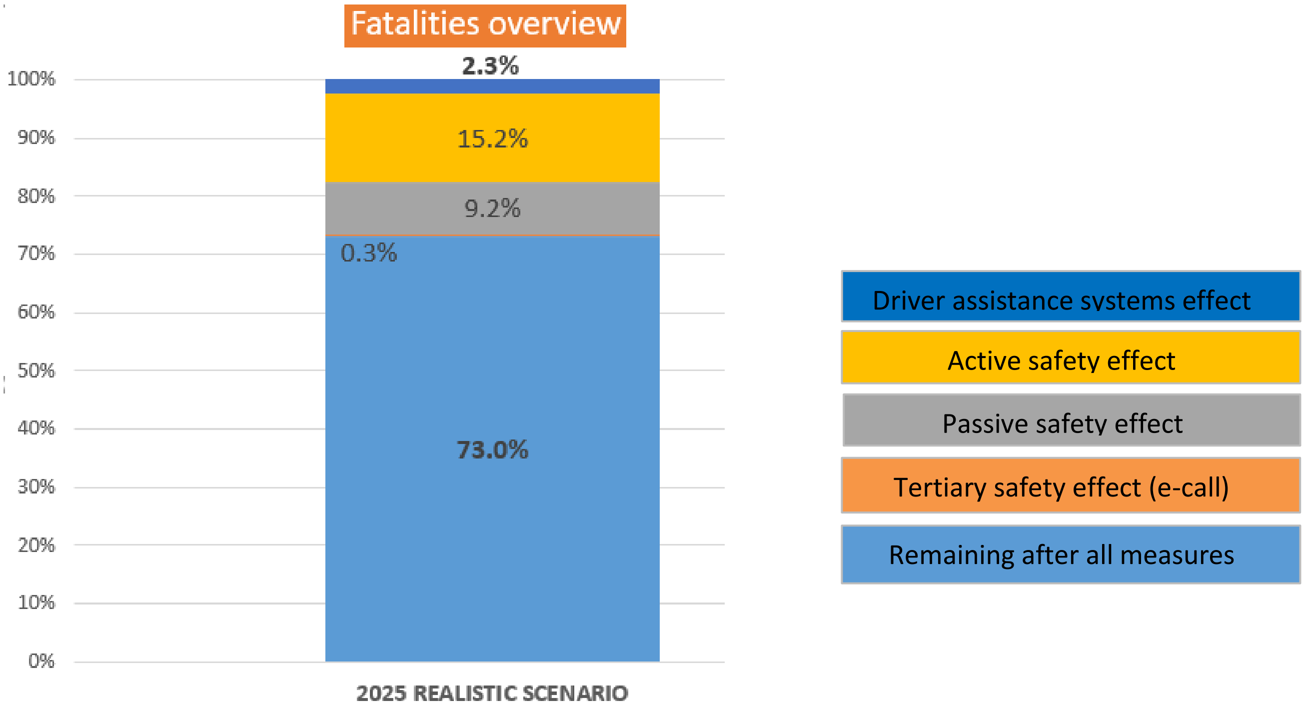


Figure 5 - Overview of contribution of each safety measure in French data by 2025

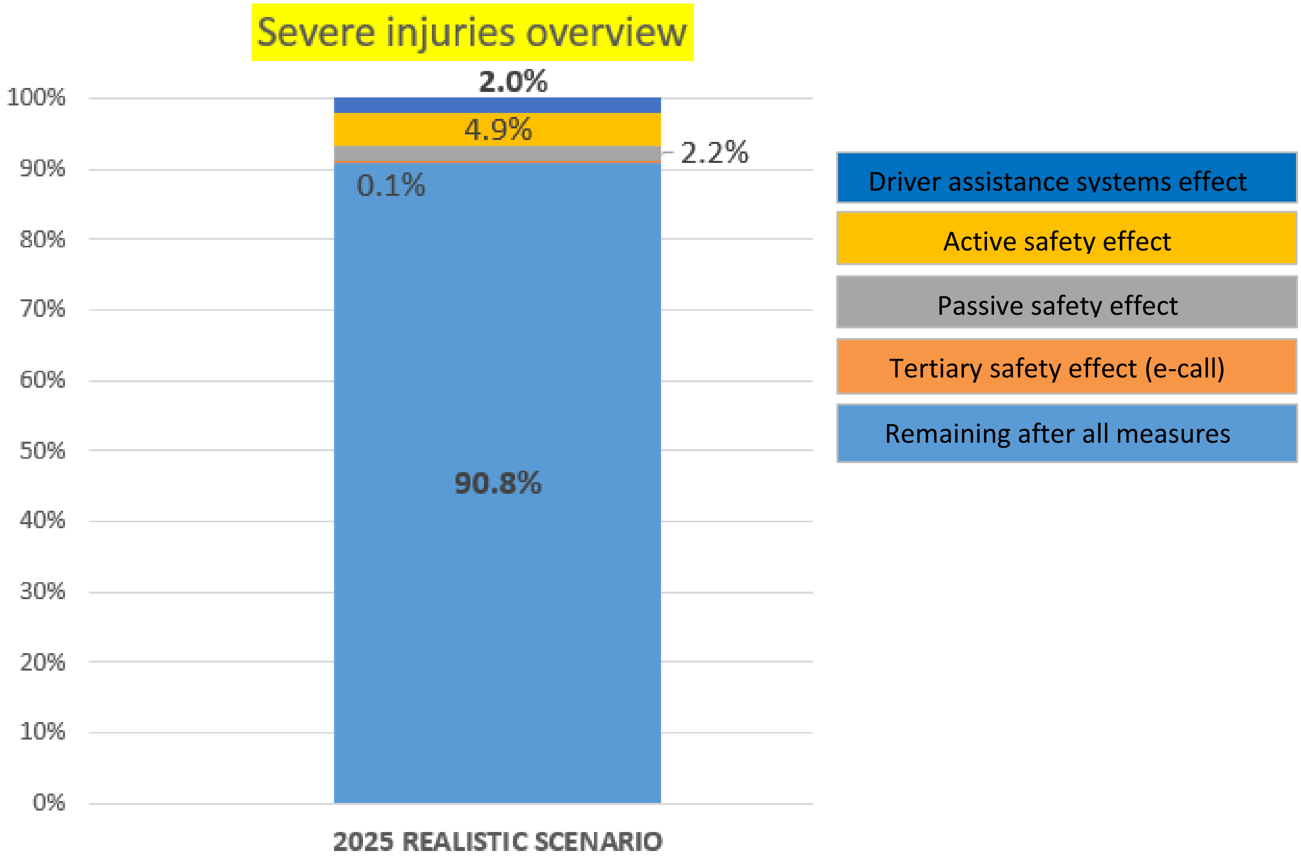


Figure 6 - Overview of contribution of each safety measure in French data by 2025

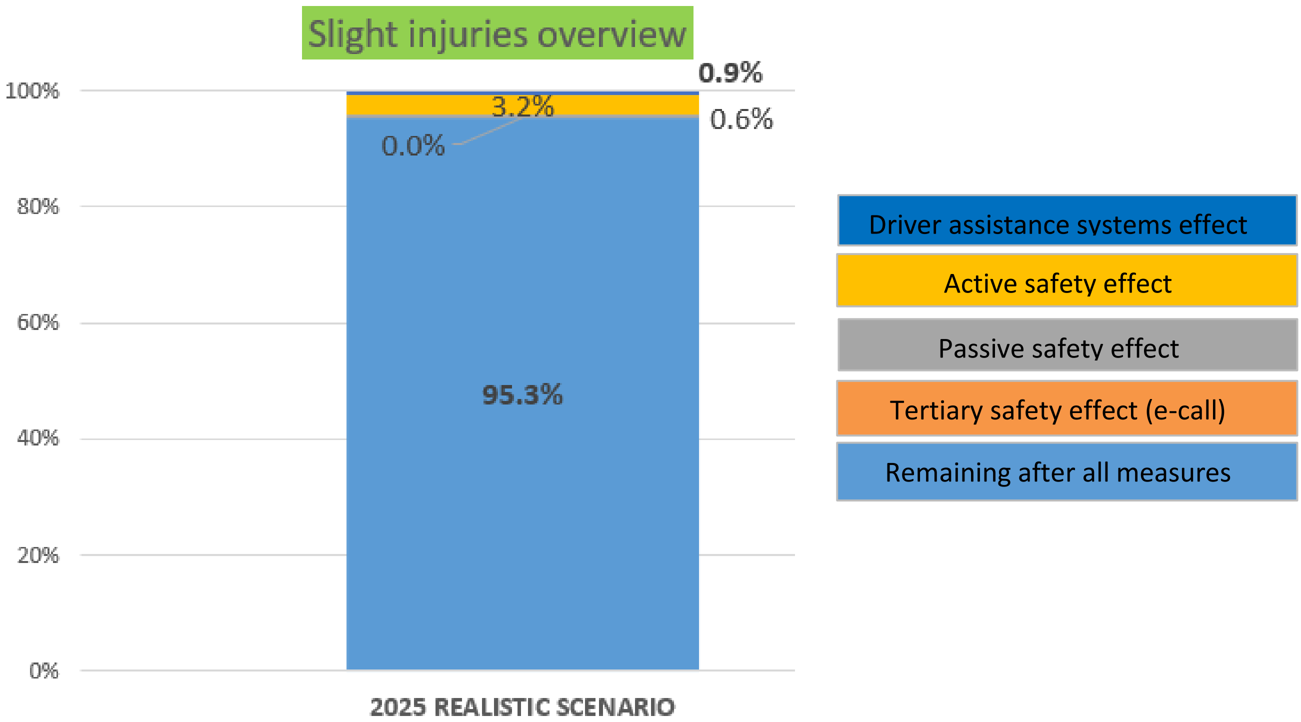


Figure 7 - Overview of contribution of each safety measure in French data by 2025

From the above figures, the contribution of active safety systems is showing the largest effect in the casualty reduction by 2025. It shows 15.2% fatalities reduction, 4.9% severe injuries reduction and 3.2% slight injuries reduction.

As summary, Table 4 compiles the most relevant cases for both countries.

Table 4 - Comparison of accidents configurations priorities France-UK

OPPONENT	COLLISION CONFIGURATION	FRANCE 2025					UK 2025				
		PRIORITY	FATAL INJ.	SERIOUS INJ.	SLIGHT INJ.	ALL	PRIORITY	FATAL INJ.	SERIOUS INJ.	SLIGHT INJ.	ALL
M1 vs VRU	VRU crossing at junction	1	7,8%	20,6%	17,7%	18,2%	N/A	Data not available			
M1 vs M1	Front-to-Side	2	6,3%	9,0%	16,6%	13,9%	1	16,7%	19,8%	26,1%	25,4%
M1 vs M1	Front-to-Front / Side-to-Side	3	2,8%	4,2%	7,6%	6,4%	2	25,4%	31,3%	24,7%	25,2%
M1 alone	Frontal, Side or Rear impact against obstacle	4	17,6%	8,8%	4,2%	6,2%	3	50,5%	36,6%	18,7%	20,3%
M1 vs VRU	VRU crossing out of junction	5	6,5%	4,7%	4,1%	4,4%	N/A	Data not available			
M1 vs M1	Rear-End	N/A	Not Relevant				4	2,4%	7,1%	25,8%	24,2%

2.1.4 Conclusion between the results and SECUR

OSCCAR results, particularly the one related to Residual Problem Analysis, led to an estimation of reduced casualties and an identification of future accident configurations which ADAS equipped vehicles would be exposed to in 2025.

The results also showed the big contribution expected from active safety ADAS systems, in terms of casualty reduction bringing road safety to a higher level. The results also show which accident configurations will remain, highlighting areas of possible improvements and limitations.

Active safety systems rely on the perception capabilities of the sensors they are equipped with, which means its effect will be dependent on aspects such as time of target detection, classification, the possible non-line of sight (NLOS) obstruction elements, environmental conditions (e.g. weather, light), etc. OSCCAR highlighted that most of the remaining accidents will be occurring at junctions, both for M1-VRU and M1-M1. Even if in the short term some of these may be addressed by newly developed systems that address these specific scenarios, (as it is expected based on the upcoming introduction of the Euro NCAP 2023 protocol for SCP), these systems would still have to face limitations such as their operation within their field of view or the presence of obstruction elements.

Therefore, if an ADAS equipped vehicle does not have full information of his entire surroundings there is always a risk that a collision occurs, and this is the area where V2X can provide an additional safety benefit. V2X systems could intervene by offering benefits such as the early provision of information to the vehicle and the driver, uses and limits different from those of ADAS and they could, eventually complement each other.

In addition, V2X brings new opportunities to reduce mortality, thanks to its ability to provide new information, anticipation and robustness. However, towards its implementation in safety related scenarios there are several challenges to be faced, such as:

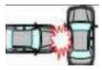
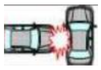
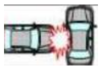
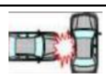
- Availability of required information: since the critical point is that the information shall be available at a critical point in time, its quality and reliability have to be ensured, and aspects such as latency and positioning accuracy shall be considered.
- Signal integration: There is extensive work on which standards to follow, and it has to be considered that the implementation of such technology into road vehicles will require detailed work

towards signal integration following standard communication procedures.

- Usability and acceptance: In order for V2X technology to achieve the expected safety benefit, it has to be used by end customers. This means that aspects such as false activations, warning perception and acceptance on road users (M1 drivers as well as VRU's) shall be addressed.

SECUR has worked on identifying which are the relevant scenarios that the project shall tackle based on an EU accident data study with experts of the relevant partners from the project. In Table 5, it can be seen how the selected scenarios for SECUR are aligned with the findings in OSCCAR project.

Table 5 - Correlation between OSCCAR and SECUR uses cases

SECUR			SYMBOL	OSCCAR	
Priority	Scenario	Road-User / Opponent		Associated Scenario	Priority
1	Heads-On	Passenger Car		Front-to-Front	3
2	Straight Crossing Path - Right Direction	Cyclist		VRU crossing at/out junction	1
3	Straight Crossing Path - Right Direction	Passenger Car		Front-to-Side	2
4	Straight Crossing Path - Right Direction	Pedestrian		VRU crossing at/out junction	1
5	Straight Crossing Path - Left Direction	Pedestrian		VRU crossing at/out junction	1
6	Loss of Control in Curve	No Opponent		Frontal, Side or Rear impact against obstacle	4
7	Straight Crossing Path - Left Direction	Passenger Car		Front-to-Side	2
8	Loss of Control in Striaght Line	No Opponent		Frontal, Side or Rear impact against obstacle	4
9	Straight Crossing Path - Left Direction	Cyclist		VRU crossing at/out junction	1
10	Rear-End - Following Vehicle	Passenger Car		Rear-End	5
11	Rear-End - Previous Vehicle	Passenger Car		Rear-End	5
12	Left Turn Across Path - Opposite Direction	Passenger Car		Front-to-Side	2
13	Left Turn Across Path - Opposite Direction	PTW		VRU crossing at/out junction	1
14	Left Turn Across Path - Left Direction	Passenger Car		Front-to-Side	2
15	Left Turn Across Path - Left Direction	PTW		VRU crossing at/out junction	1

2.2 ADAS PERFORMANCES AND LIMITATIONS

2.2.1 ADAS SENSORS CHARACTERISTICS

The positive contribution of ADAS to road safety based on real field data has been analysed in various studies, [8]. It is also expected that these technologies will evolve and provide further road safety benefits. However, the effectiveness of such technologies is related to aspects such as detection accuracy, light variation, and speed, as stated by the Insurance Institute for Highway Safety (IIHS) in their 2022 study [11].
It also has to be considered the wide variety of sensors that these technologies may be equipped with, making necessary to understand the benefits and drawbacks of each of them:

Table 6 - Positive and negative aspects of the main ADAS sensors

ADAS SYSTEM	BENEFITS	DRAWBACKS
CAMERAS	- Limited cost - Classification and quality under optimal conditions - Easily understandable rendering	- Classification by night / low luminosity / too high luminosity (=glare) - Compromise to be made between range and angle of vision - Impacted by the speed - Difficulty of maintaining the quality with the climate (rain, fog, etc.) - Limited by the topography (=NLOS)
RADARS	- Non impacted by weather, luminosity or speed - Adaptable range and angle of vision - High detection and classification ability	- Relatively high cost - Low classification ability - Complex analysis of raw signals for rendering
LIDARS	- Very effective classification abillity, even by night - Good resolution - Long range	- Very high cost - Relatively impacted by speed, weather and direct light - Very impacted by speed - Lack of precision in classification of similar objects
GPS	- Good positioning and speed evaluation - Emergency situations communications (=E-call procedures)	- Impacted by weather conditions - Only informs about positioning/movement

The wide variety of sensors existing shows that a combination of them is needed in order to find optimum safety systems that can perform well in various aspects such as object detection, classification, relative information, edge definition, range of visibility, adverse weather, adverse lightning, positioning, etc [12].

2.2.2 ADAS EFFECTIVENESS

The effectiveness of ADAS as active safety systems can be estimated using a retrospective approach or a predictive approach. The first one will rely on studies performed on the field, after the introduction of safety technology in the market, by gathering data of how systems performed and determining effectiveness rates for each technology. The prospective approach relies on predicting the effectiveness of the technology before its market introduction, something which can be done by the use of simulation.

SECUR has used results from the residual problem analysis conducted in OSCCAR project, where the retrospective approach was considered. For each of the safety technologies in the scope, effectiveness values were considered based on literature review of field studies. In some cases, when data was not available an assumption was considered.

The effectiveness values were defined in two scenarios, a realistic one and an optimistic one. The difference among those was mainly that realistic values would consider mean values of the effectiveness values provided from literature, whereas optimistic ones would consider either the upper confidence intervals of the studies in literature, or certain assumptions. The effectiveness is further differentiated between avoidance and mitigation and took into account the different casualty levels:

fatalities, severe injuries and slight injuries. An overview of the defined values is shown in Table 7, with its corresponding references and assumptions used being listed respectively in Table 8 and Table 9.

Table 7 - ADAS' effectiveness (OSCCAR project)

Short name	Effectiveness (REALISTIC or BASELINE SCENARIO)							Effectiveness (OPTIMISTIC SCENARIO)						
	References	Avoidance			Mitigation			References	Avoidance			Mitigation		
		Fatality	Serious	Slight	Fatality	Serious	Slight		Fatality	Serious	Slight	Fatality	Serious	Slight
ALC	(1)	13.0%	13.0%	13.0%	NA	NA	NA	(99)*11	100.0%	100%	100%	NA	NA	NA
TPM	(2)	4.00%	4.00%	4.00%	NA	NA	NA	(2)	20%	20%	20%	NA	NA	NA
TSR	(99)*7	9.5%	9.5%	9.5%	3.4%	4.2%	N/A	(99)*12	14%	14%	14%	6%	7%	NA
DIS	(1)	16.70%	16.70%	16.70%	NA	NA	NA	(99)*12	24.2%	24.2%	24.2%	NA	NA	NA
ISA	(1)	19%	19%	19%	6.7%	8.4%	N/A	(3)	37%	51%	51%	6.7%	8.4%	NA
IW	(4)	~~7.5%~~ 16.6%	~~15.3%~~ 13.6%	~~15.3%~~ 13.6%	NA	NA	NA	(4)	26.60%	29.60%	29.60%	NA	NA	NA
LCA	(5)	23.0%	23.0%	23.0%	NA	NA	NA	(5)	44%	44%	44%	NA	NA	NA
AES	(99)*8	M1: 19% Ped:24.4% Cyc:27.5%	M1: 19% Ped: 21% Cyc: 16.4%	M1: 42% Ped:42% Cyc:38%	NA	NA	NA	(99)*8	54.8	54.8	54.8	NA	NA	NA
ESC	(1)	38%	21%	21%	NA	NA	NA	(11)	55%	27%	27%	NA	NA	NA
ACC	(4)	45.0%	30.0%	30.0%	NA	NA	NA	(99)*12	60.8%	40.5%	40.5%	NA	NA	NA
LDW&LKA	(1)	53%	38.5%	38.5%	NA	NA	NA	(6)	75%	75%	75%	NA	NA	NA
AEB	(1)	19%	19%	42%	19%	19%	NA	(6)	53%	53%	53%	53%	53%	NA
AEB-VRU	(1)	Ped:24.4% Cyc:27.5%	Ped: 21% Cyc: 16.4%	Ped:42.1% Cyc:32.8%	Ped:24.4% Cyc:27.5%	Ped: 21% Cyc: 16.4%	NA	(6)	54.8%	54.8%	54.8%	54.8%	54.8%	NA
REV	(7)	41%	41%	41%	NA	NA	NA	(7)	61%	61%	61%	61%	61%	NA
ESS	(1)	5%	10%	20%	20%	20%	NA	(99)*12	8.0%	14.0%	28.0%	28.0%	28.0%	NA

Table 8 - List of references used in the OSCCAR Residual problem analysis to define effectiveness values of active safety systems

No.	Reference
1	Seidl et al, 2018. Cost-effectiveness analysis of Policy Options for the mandatory implementation of different sets of vehicle safety measures – Review of the General Safety and Pedestrian Safety Regulations. Technical Annex to GSR2 report. European Commission.
2	CLEPA. Position paper on Tyre Pressure Monitoring Systems (Review of the General Safety regulation). 2017
3	Barrow et al. Effectiveness estimates for proposed amendments to the EU's General and Pedestrian Safety Regulations (Published Project Report PPR844). TRL, study performed for ACEA. 2017
4	Wilmink et al, 2008. D4 Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe. eIMPACT project.
5	Cicchino, Jessica B. Effects of blind spot monitoring systems on police-reported lane-change crashes. IIHS. 2017
6	No public reference available
7	Keall et al, 2017. Real-world evaluation of the effectiveness of reversing camera and parking sensor technologies in preventing backover pedestrian. Accident Analysis and Prevention, 2017 (39-43)

Table 9 - List of assumptions considered in the OSCCAR Residual problem analysis to define effectiveness values of active safety systems

No	Assumption	Details
(99)*7	Consider half of ISA effectiveness	- Driver may consider speed has a bigger safety impact) - There are more speed related crashes than due to sign ban
(99)*8	Same as AEB-VRU	Scenarios are similar, the change point is how the accident is avoided/mitigated
(99)*11	No alcohol case	Consider no remaining accident is due to alcohol
(99)*12	Additional percentage applied for optimistic values	Based on realistic effectiveness value and penetration rate confidence level, rule set was applied

2.2.3 ADAS LIMITATIONS

ADAS active safety systems have benefits in terms of road safety, but they also have to face other challenges, either technical or technological. Some of them are:

- Limitations related to the field of view (obstructions / NLOS): The sensors will be able to detect objects within their field of view, so objects hidden by obstructions or not within the field of view will be a challenge.
- Impact of weather conditions: The systems may have some performance limitations under certain weather conditions such as heavy rain or fog.
- Sensitivity to luminosity: Sensors may have some limitations when there is a sudden change of brightness or due to glare effect.
- Sensor blocking: In some cases, sensors may be blocked by dirt or dust or objects, which will not allow them to operate properly.
- Dynamic effects: In some cases, abrupt manoeuvres by traffic participants may be so sudden that systems may not have time to react.
- Acceptance and Usability: The systems are effective also when they are used, so aspects that can lower acceptance of the systems such as false positives are very critical.
- Overall system robustness: The presence of different environments, objects and trajectories can have an impact on system performance
- Penetration rate: The penetration rate is driven by the market and by its cost, which with the need of several sensors increases rapidly making it more challenging to be present in more affordable vehicles.

Besides their impact on casualties' avoidance and accident mitigation, ADAS are limited by technical and physical aspects, in the same way ADAS' tools are:

- Impacted by obstruction / NLOS
- Possible important cost: better performances are brought by higher quality sensors which traditionally increase their cost
- Low to mid end vehicles may only be equipped to meet legal requirements
- Impacted by luminosity level and glare
- Robustness issues faced with the variability of contexts: different environments, opponents, nonlinear trajectories
- Risks of false positives and false negatives
- Weather conditions
- Speed

2.2.4 Benefits and potential of V2X to improve ADAS

Table 10 - Benefits and drawbacks of V2X implementation

	BENEFITS	DRAWBACKS
V2X	- Provides additional information to the systems. Knowledge of the road user type (classification) and their dynamic parameters (speed, positioning, driving lane, heading, accel/braking, turning indicator, airbag status, etc). These data could be used for path prediction. - Almost not impacted by ADAS' weaknesses (obstruction/NLOS, luminosity, weather conditions, speed, etc). - Ability to classify, communicate, confirm information about the opponent: infrastructure/vehicle/VRU, fix or mobile, etc. - Improve the opponent position information. - Allow new services to the user through the share of specific situation information with a wide range (crashes, traffic jam, VRU on the road, roadwork, slippery road, etc.). - Short range technologies offer V2X services without infrastructure cost. Free for the user anytime, anywhere.	- Not yet V2X safety integrity level (ASIL). - Need to ensure the quality and reliability of the transmitted information. V2X highly dependent of the positioning accuracy and confidence. - No consensus yet on the V2X communication technology to be used. - Not yet regulation of V2X open ecosystem (not proprietary) cross OEMs. Direct and indirect communication ecosystems should be connected in the future. Today an example for direct communication (V2V, V2I, V2VRU) is the European Certificate Trust list (ECTL). For indirect communication (V2N) an equivalent solution should be developed in the upcoming years. - Lack of test in real environment on highly congested situation for all direct technologies (ITS-G5 and PC5). - Remaining questions on the business model around connected infrastructure and especially who will fund the infrastructure costs.

2.2.5 Conclusion

Besides the positive impact ADAS have on injuries mitigation and accidents avoidance, they are now facing their technological and physical limits in order to be further improved. V2X is a key answer to push those limits since it is not subject to the same constraints.

Active safety ADAS are introduced on the market with the expectation to have a positive effect on road safety, as literature review of the residual problem analysis performed in OSCCAR showed. Thanks to the consumer rating program from Euro NCAP, today these systems are widespread in the European market, since they are part of the assessment of the overall safety rating of tested vehicles, which represent a large majority of vehicles in the European Market.
It is also expected that new ADAS functionalities will arise in the coming years, in part following the new requirements that Euro NCAP will define and also standard systems will gain in robustness thanks to technology advances.

However, there will be situations where these systems will still face challenges, due to limitations in field of view of the sensors and/or the presence of obstructions. In such situations there is a large potential for V2X technology to provide a safety benefit. Besides the potential benefit of V2X technology, its readiness also needs to address several challenges before it is widely deployed.

3. Summary of the discussions that have led to the final SECUR UCs selection

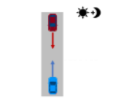
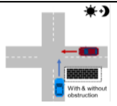
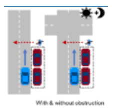
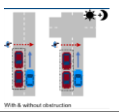
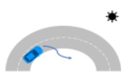
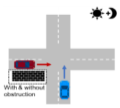
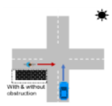
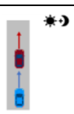
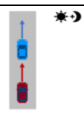
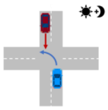
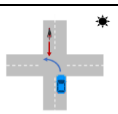
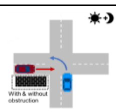
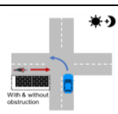
3.1 Evolution of the SECUR use cases between WP1 and WP3

3.1.1 WP1 state

The work package 1 (WP1), as the starting point of the project, identified the 15 major Killed and Severely Injure (KSI) crash scenarios and described them by road configuration, types of opponents, pre-crash manoeuvres, and their relative frequencies all over Europe. In a second stage the main specific criteria characterising each of these crash scenarios where defined.

Table 11 below summarizes the crash scenarios selected and studied in WP1:

Table 12 - SECUR WP1 use cases [1]

SECUR WP1 Use cases							Euro NCAP associated scenario
WP1 Scenario number	**Designation**	**Acronym**	**Opponent**	**Pictogram**	**Obstruction**	**Description**	
1	Oncoming	/	Passenger car		No	A collision where a vehicle is travelling along a straight path and strikes another vehicle travelling in the opposite direction.	CCFhol & CCFhos (Coming in 2023)
2	Straight Crossing Path – Right Direction	SCP-RD	Bicyclist		Yes & No	A collision in which a vehicle travels forwards along a straight path across a junction, towards a bicyclist crossing the junction on a perpendicular path, from the right direction.	CBNA & CBNAO
3	Straight Crossing Path – Right Direction	SCP-RD	Passenger car		Yes & No	A collision in which a vehicle travels forwards along a straight path across a junction, towards a vehicle crossing the junction on a perpendicular path, from the right direction.	CCCscp (Coming in 2023)
4	Straight Crossing Path – Right Direction	SCP-RD	Pedestrian		Yes	A collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian.	CPNA
5	Straight Crossing Path – Left Direction	SCP-LD	Pedestrian		Yes	A collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the farside.	CPFA & CPNCO
6	Loss Of Control in CUrve	LOC-CU	None		No	An accident where the vehicle is alone, driving in a curve and the control of the vehicle is lost.	Not covered.
7	Straight Crossing Path – Left Direction	SCP-LD	Passenger car		Yes & No	A collision in which a vehicle travels forwards along a straight path across a junction, towards a vehicle crossing the junction on a perpendicular path, from the left direction.	CCCscp (Coming in 2023)
8	Loss Of Control in Straight Line	LOC-SL	None		No	An accident where the vehicle is alone, driving in a straight line and the control of the vehicle is lost.	No
9	Straight Crossing Path – Left Direction	SCP-LD	Bicyclist		Yes & No	A collision in which a vehicle travels forwards along a straight path across a junction, towards a bicyclist crossing the junction on a perpendicular path, from the left direction.	CBFA
10	Rear End - Following Vehicle	RE-FV	Passenger car		No	A collision in which a vehicle travels forwards towards another vehicle that is travelling in the same direction and the frontal structure of the vehicle strikes the rear structure of the other. From the following vehicle point of view.	CCRm & CCRb & CCRs
11	Rear End - Previous Vehicle	RE-PV	Passenger car		No	A collision in which a vehicle travels forwards towards another vehicle that is travelling in the same direction and the frontal structure of the vehicle strikes the rear structure of the other. From the previous vehicle point of view.	Not covered. Case partially covered by CCRm & CCRb & CCRs but not with this point of view (previous vehicle).
12	Left Turn Across Path – Opposite Direction	LTAP/OD	Passenger car		No	A collision in which a vehicle turns across the path of an oncoming vehicle, and the frontal structure of the vehicle strikes the front structure of the other.	CCFtap
13	Left Turn Across Path – Opposite Direction	LTAP/OD	PTW		No	A collision in which a vehicle turns across the path of an oncoming motorcycle, and the frontal structure of the vehicle strikes the front structure of the other.	CMFtap (Coming in 2023)
14	Left Turn Across Path – Left Direction	LTAP/LD	Passenger car		Yes & No	A collision in which a vehicle turns across the path of a vehicle crossing the junction on a perpendicular path from the left direction.	'Not covered. Partially covered by CCCscp.
15	Left Turn Across Path – Left Direction	LTAP/LD	PTW		Yes & No	A collision in which a vehicle turns across the path of a motorcycle crossing the junction on a perpendicular path, from the left direction.	Not covered. Partially covered by CMC, coming in 2025.

3.1.2 WP3 USE CASES

As presented in the introduction of this report in section 1.2, the main objective of this work package is to precisely define the final selection of the SECUR use cases considering several aspects: general, accidentology, test, connectivity, safety behaviour, and SECUR proposal for the V2X integration at Euro NCAP. This final list was derived from the WP1 crash selection.

Euro NCAP testing scenarios are clustered by types of safety and timeline. These four clusters are called "rating schemes" and SECUR considers all of them in its scope: crash avoidance, safe driving, post-crash safety and crash protection.

Table 13 below presents the final SECUR use case selection based on the WP3 work.

Table 14 - WP3 use cases

Type		Opponent	WP3 N.#	WP3 Use case
SAFETY	Crash avoidance	Passenger car	#3	**SCP-RD Passenger Car** Crossing passenger car from right side at an intersection.
			#7	**SCP-LD Passenger Car** Crossing passenger car from left side at an intersection.
			#10	**RE-FV Passenger Car** Rear-end braking accident between two passenger cars.
			#12a	**LTAP-OD Passenger Car** Passenger car turning left across the path of another vehicle coming from the opposite
			#01	**Head-On Passenger Car** Face to face impact between two passenger cars.
			#12b	**SCP-OD/LTAP Passenger Car** Passenger car going straight at an intersection and having an accident with a vehicle from the opposite direction turning left across its path.
		Powered two wheeler	#13	**LTAP-OD PTW** Passenger car turning left across the PTW path coming from the opposite direction.
			#015	**SCP-LD PTW** Crossing PTW from left side at an intersection.
		Bicyclist	#2	**SCP-RD Bicyclist** Crossing bicyclist from right side at an intersection.
			#9	**SCP-LD Bicyclist** Crossing bicyclist from left side at an intersection.
		Pedestrian	#4	**SCP-RD Pedestrian** Crossing pedestrian from right side.
			#5	**SCP-LD Pedestrian** Crossing pedestrian from left side.
	Safe driving	All	/	**Local Hazard** A situation, an event, or a state towards in which a vehicle is driving.
		None	/	**Red-light violation ego** Ego driver behavior not in line with traffic light status.
		All	/	**Red-light violation opponent** Red light violation of another road user (opponent) at an intersection.
	Post-crash safety	All	/	**V2X post-crash warning** The capability of a vehicle to warn the surroundings road users after an accident.
	Crash protection	All	/	**V2X crash protection (safety opportunity)** Fusion of V2X with pre-crash systems to improve the knowledge of the situation and the

Note: Pictograms describing the use cases are available in the section 4 of this report.

3.1.3 Link between WP1 and WP3 use cases

This section describes the links between WP1 and WP3 use cases with a dedicated table related to the four different Euro NCAP clusters (crash avoidance, safe driving, post-crash safety and crash protection). Every WP3 use case is derived from at least one WP1 use case, sometimes several, or even all.

Crash avoidance rating scheme:

Table 15 - Links between WP3 crash avoidance rating scheme use cases and WP1

WP3 USE CASE		WP1 CORRESPONDING USE CASE	EURO NCAP ASSOCIATED SCENARIO
WP3#3	**SCP-RD Passenger Car** Crossing passenger car from right side at an intersection.	**Derived from WP1#3 (SCP-RD Passenger Car)**	CCCscp
WP3#7	**SCP-LD Passenger Car** Crossing passenger car from left side at an intersection.	**Derived from #7 (SCP-LD Passenger Car) and #14 (LTAP/LD Passenger Car)**	CCCscp
WP3#10	**RE-FV Passenger Car** Rear-end braking accident between two passenger cars.	**Derived from WP1#10 (RE-FV Passenger Car)**	CCRb
WP3#12a	**LTAP-OD Passenger Car** Passenger car turning left across the path of another vehicle coming from the opposite direction.	**Derived from WP1#12 (LTAP-OD Passenger Car)**	CCFtap
WP3#01	**Head-On Passenger Car** Face to face impact between two passenger cars.	**Derived from WP1#1 (Oncoming)** WP1#1 was divided into three use cases in accordance with the WG3, in order to make this scenario more coherent: - #01: Head-On (PC) - #12b: SCP-OD/LTAP (PC) - Local Hazard (Wrong way driving)	CCFhol & CCFhos
WP3#12b	**SCP-OD/LTAP Passenger Car** Passenger car going straight at an intersection and having an accident with a vehicle from the opposite direction turning left across its path.	**Derived from WP1#1 (Oncoming)** (Same explanation as above)	Partially covered by CCFtap, the other point of view.
WP3#13	**LTAP-OD PTW** Passenger car turning left across the PTW path coming from the opposite direction.	**Derived from WP1#13 (LTAP-OD PTW)**	CMFtap
WP3#015	**SCP-LD PTW** Crossing PTW from left side at an intersection.	**Derived from WP1#15 (SCP-LD PTW)**	CMC
WP3#2	**SCP-RD Bicyclist** Crossing bicyclist from right side at an intersection.	**Derived from WP1#2 (SCP-RD Bicyclist)**	CBNA & CBNAO
WP3#9	**SCP-LD Bicyclist** Crossing bicyclist from left side at an intersection.	**Derived from WP1#9 (SCP-LD Bicyclist)**	CBFA
WP3#4	**SCP-RD Pedestrian** Crossing pedestrian from right side.	**Derived from WP1#4 (SCP-RD Pedestrian)**	CPNA
WP3#5	**SCP-LD Pedestrian** Crossing pedestrian from left side.	**Derived from WP1#5 (SCP-LD Pedestrian)**	CPFA & CPNCO

Safe driving rating scheme:

Table 16 - Links between WP3 safe driving rating scheme use cases and WP1

WP3 USE CASE	WP1 CORRESPONDING USE CASE	EURO NCAP ASSOCIATED SCENARIO
Local Hazard A situation, an event, or a state towards in which a vehicle is driving.	**Derived from WP1#1 (Oncoming), WP1#6 (LOC-CU), WP1#8 (LOC-SL), WP1#10 (RE-FV) and WP1#11 (RE-PV)**	SAS protocol
Red-light violation ego Ego driver behaviour not in line with traffic light status.	**Derived from all intersection use cases**	SAS protocol
Red-light violation opponent Red-light of another road user (opponent) violation at an intersection.	**Derived from all intersection use cases**	Not covered

Post-Crash safety rating scheme:

Table 17 - Links between WP3 post-crash safety rating scheme use cases and WP1

WP3 USE CASE	WP1 CORRESPONDING USE CASE	EURO NCAP ASSOCIATED SCENARIO
V2X post-crash warning The capability of a vehicle to warn the surroundings road users after an accident.	**Derived from WP1#6 (LOC-CU), WP1#8 (LOC-SL) and from all use cases**	Not covered

Crash protection rating scheme (safety opportunity identified but not studied in SECUR):

Table 18 - Links between WP3 crash protection rating scheme use cases and WP1

WP3 USE CASE	WP1 CORRESPONDING USE CASE	EURO NCAP ASSOCIATED SCENARIO
V2X crash protection Fusion of V2X with pre-crash systems to improve the knowledge of the situation and the effectiveness.	**Derived from WP1#11 (RE-PV) and from all use cases**	Not covered

3.2 COUNTERMEASURES

3.2.1 COUNTERMEASURES DEFINITIONS

To support the definition of the V2X use cases and of the system expectations, six countermeasure's types were selected and defined based on the ETSI C-ITS road safety model [5].

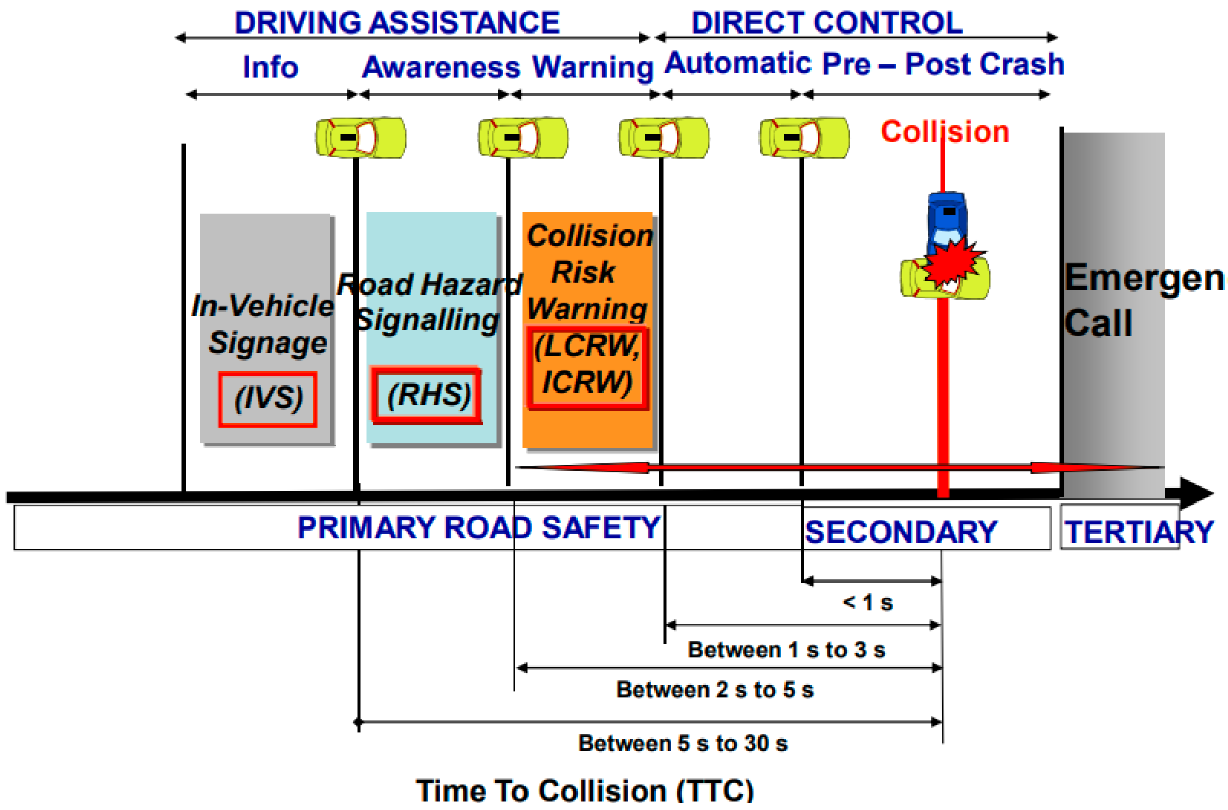


Figure 8 – ETSI Road safety model in C-ITS [5]

Those same documents were used as a basis to define the Time-To-Collision countermeasures that suit the use-cases the best:

- Driver **Information**:
  The purpose of this application is to provide static (or semi-static) information to the driver for a safe and comfort drive. V2X can bring for example in-Vehicle Signage (IVS) information on the road to the driver (e.g. dynamic speed limit information, dynamic lane management, etc.).

- Driver **Awareness**:
  The purpose of this application is to point the driver's attention to a situation ahead on its vehicle trajectory that has the potential to become dangerous or critical if overlooked by the driver. This service can for example increase the driver vigilance to avoid a collision, in situations, which do not require an immediate action (e.g., roadwork, traffic jams, VRU awareness, etc).

- Driver **Warning**:
  The purpose of this application is to issue alerts to the driver requiring an immediate action to avoid an accident (e.g. emergency brake, stay in lane, collision risks, etc). Due to the

urgency of the situation, V2X might be used as an additional ADAS sensor.

- Vehicle **Action**:
  Mitigation and crash avoidance by active safety systems. Due to the criticality of the situation, V2X might be used as an additional sensor. According to SECUR, it might not be possible to rely on V2X for Automotive Safety Integrity Level (ASIL) level applications before 2029. Because of this, the Vehicle Action category distinguishes between non-safety-critical and Safety-critical actions:
  - **Non-safety-critical Vehicle Action** is not subject to ASIL requirements due to the low consequence severity. V2X is very relevant to reinforce quickly (2026) this applications' type (e.g. speed reduction, acceleration limitation, system parameter/sensitivity update, lane keeping, etc.). Non-safety-critical vehicle actions combined with V2X are already enough to have a quick impact on road safety.
  - **Safety-critical Vehicle Action** is subject to ASIL requirements due to the high consequence severity. V2X should ensure enough safety confidence (ASIL level) before data fusion with those applications like Autonomous Emergency Braking (AEB).

- **Pre-crash**:
  The purpose of this application is to bring information to the vehicle active systems in case of upcoming crash in order to pre-empt crash safety systems such as seatbelts and automatic closing windows.

- **Post-crash**:
  The purpose of this application is to bring information to the surrounding road users to avoid additional accidents or other security issues.

Driver information countermeasure will not be detailed below (except in Safe driving rating scheme) as this countermeasure is not directly linked to safety aspects but more to comfort.

3.2.2 Countermeasures associated to SECUR use cases

V2X is a type of technology relevant for the three following Euro NCAP rating schemes: crash avoidance, safe driving, and post-crash safety. SECUR considers crash protection as a V2X safety opportunity, however, no studies were performed on this one.

Table 19 below indicates the link between Euro NCAP rating schemes and the countermeasures defined in the previous section. As shown in this table, not all countermeasures are relevant for all rating schemes.

Table 20 - Relevant V2X countermeasures by Euro NCAP rating schemes

	Countermeasures					
Euro NCAP rating scheme	Information	Awareness	Warning	Action	Pre-crash	Post-crash
Crash Avoidance		x	x	x		
Safe Driving	x	x	x			
Post-crash Safety						x
Crash Protection					x	

Table 21 below associates WP3 use cases and their relevant countermeasures.

Table 22 - Use cases and countermeasures association

Type	Opponent	WP3 Use case	Countermeasures: Information	Countermeasures: Awareness	Countermeasures: Warning	Countermeasures: Action	Countermeasures: Pre-crash	Countermeasures: Post-crash
Crash avoidance	Passenger car	**SCP-RD Passenger Car** Crossing passenger car from right side at an intersection.	✗	✓	✓	✓	✗	✗
		SCP-LD Passenger Car Crossing passenger car from left side at an intersection.	✗	✓	✓	✓	✗	✗
		RE-FV Passenger Car Rear-end braking accident between two passenger cars.	✗	✗	✓	✓	✗	✗
		LTAP-OD Passenger Car Passenger car turning left across the path of another vehicle coming from the opposite direction.	✗	✗	✗	✓	✗	✗
		Head-On Passenger Car Face to face impact between two passenger cars.	✗	✓	✓	✓	✗	✗
		SCP-OD/LTAP Passenger Car Passenger car going straight at an intersection and having an accident with a vehicle from the opposite direction turning left across its path.	✗	✗	✓	✓	✗	✗
	Powered two wheeler	**LTAP-OD PTW** Passenger car turning left across the PTW path coming from the opposite direction.	✗	✓	✗	✓	✗	✗
		SCP-LD PTW Crossing PTW from left side at an intersection.	✗	✓	✓	✓	✗	✗
	Bicyclist	**SCP-RD Bicyclist** Crossing bicyclist from right side at an intersection.	✗	✓	✓	✓	✗	✗
		SCP-LD Bicyclist Crossing bicyclist from left side at an intersection.	✗	✓	✓	✓	✗	✗
	Pedestrian	**SCP-RD Pedestrian** Crossing pedestrian from right side.	✗	✓	✓	✓	✗	✗
		SCP-LD Pedestrian Crossing pedestrian from left side.	✗	✓	✓	✓	✗	✗
Safe driving	All	**Local Hazard** A situation, an event, or a state towards in which a vehicle is driving.	✓	✓	✓	✗	✗	✗
	None	**Red-light violation ego** Ego driver behavior not in line with traffic light status.	✗	✓	✓	✗	✗	✗
	All	**Red-light violation opponent** Red light violation of another road user (opponent) at an intersection.	✗	✗	✓	✗	✗	✗
Post-crash safety	All	**V2X post-crash warning** The capability of a vehicle to warn the surroundings road users after an accident.	✗	✗	✗	✗	✗	✓
Crash protection	All	**V2X crash protection (safety opportunity)** Fusion of V2X with pre-crash systems to improve the knowledge of the situation and the effectiveness.	✗	✗	✗	✗	✓	✗

✓	: Countermeasure relevant for this use case
✗	: Countermeasure not relevant for this use case

3.2.3 Human-Machin Interface (HMI)

HMI can be very beneficial and increase safety by providing additional information to drivers to help them better understand a certain situation and make a decision. However, it can also have a negative impact if poorly implemented. Reaching the ideal level of information is difficult to find but is necessary in order not to confuse the driver. In addition, too many alerts or information could discredit the system if the conditions (speed, localization, etc) are not well defined and if too many false positive situations occur.

The subject of HMIs was not deeply treated in SECUR. However, some aspects were identified as necessary to ensure safety benefits. Firstly, the HMI should be clear, easy, and quick to understand (e.g. clear pictograms, large and concise texts, etc). Secondly, a progression in the intensity is required (i.e. visual, sound and haptic) depending on the severity of the situation.

Example* of a progressive approach by driver countermeasures type:

- Information: visual
- Awareness: visual ("yellow") and/or light sound and/or haptic
- Warning: visual ("red"), strong sound and/or intense haptic

*: Example coming from WG3 discussions not from an HMI study.

One potential approach for awareness could also be the HMI showing the surrounding objects approaching. This possibility is even less intrusive than having driver alert and without false positive by design, as all the relevant objects are shown on the HMI.

3.3 Driver alert timings

According to the literature and the common thought, one second is the legit reaction time to consider, as this value is indeed commonly accepted by professionals since it is also instructed during driving lessons. However, this value only includes the perception and decision phase, not the driver reaction.

If we study more in depth the data available on this topic, we learn that reaction time including the above-mentioned perception/decision phase depends on age, awareness and experience. The average reaction time of 0.8 to 1.2 seconds is mainly reached by drivers between 25 and 40 years old, focused on their driving [13]. Besides this general data, we can also notify that the reaction time can decrease to 0.3/0.4/0.5 seconds for experienced and focused drivers and to less than 0.4 seconds for professional and race drivers. It can obviously also increase until more than 3 seconds depending on the driver's age, the climate, and the consumption of alcohol and/or drugs.

Euro NCAP considers 1.2 second as a good timing for a driver to evaluate a risk, take a decision and move his foot to the braking pedal (this timing does not include the braking action), as it can be seen in the protocols. To evaluate FCW, Euro NCAP trigger a testing robot braking (based on a define braking model) 1.2 s after the warning.

3.3.1 Driver warning model – ALKS regulation (R157)

According to the ALKS regulation (R157) [14], the decision time of a skilled driver is 1.15 seconds. In the case of a braking driver reaction the necessary timing is about 1.75 seconds. These timings are based on a skilled human performance model detailed below in figure 9.

Skilled human performance model

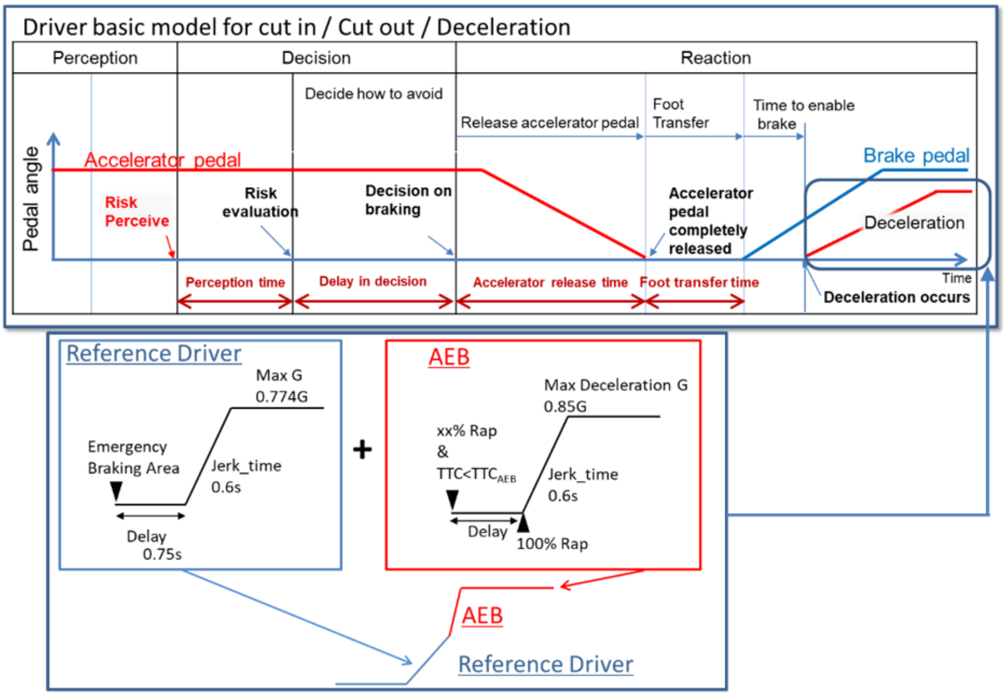


Figure 10 – Skilled human performance model from ALKS regulation

Table 23 - Summary of skilled human decision and reaction timings based on ALKS regulation

Driver model phase	Timing (s)	Cumulated timing (s)
Risk perception point	/	0
Risk evaluation time	0.4	0.4
Time duration from having finished perception until starting deceleration	0.75	1.15
Jerking time to full deceleration (driver action)	0.6	1.75
Total time of the skilled human model (case: braking)		**1.75**

According to the above human model summarized in table 24, a skilled driver needs 1.75 seconds to perceive the risk, evaluate it, take a decision and applying the brake.

3.3.2 Driver awareness and warning timing methodology proposal

The following section describes a possible methodology to identify the relevant timing to push a driver awareness or warning alert.

Alert relevant time = Assessment_time + Required_action_time

With

- Assessment_time = driver perception and decision time
- Required_action_time = time needed to achieve the expected action by the driver

Awareness alert expects to create the driver awareness of a danger ahead on its vehicle trajectory. This does not require an immediate action but more to adapt its driving behaviour to the situation. The maximum expectation is a soft action like stop accelerating or soft braking. For awareness indications, an action cannot be assumed. It is the role of the driver to identify if and which behaviour change is needed. Nevertheless, the awareness message should be delivered sufficiently early that the accident could be avoided by soft action (such as soft braking).

Awareness should be raised at TTC > ($T_{assessment\_awareness} + T_{potential\_soft\_action\_awareness}$)

Warning should be raised at TTC > ($T_{assessment\_warning} + T_{action\_warning}$)

With

- $T_{assessment\_warning}$ = 1.2s (NCAP)
- $T_{action\_warning}$ = time required for braking with $-8 m/s^2$ (robot test)
- $T_{assessment\_awareness}$ > $T_{assessment\_warning}$, e.g. 2-4s
- $T_{potential\_soft\_action\_awareness}$ = time required for braking with $-4 m/s^2$ (non-safety relevant braking)

$T_{assessment\_awareness}$ and $T_{assessment\_warning}$ are not equal as the expectations from the driver are not the same. In addition, a warning always required a strong action (i.e. braking) from the driver, while an awareness can be very diverse. The time to perceive and decide what is the right behaviour is not the same between these two alerts because of the large number of possible situations and reactions for awareness. This is why $T_{assessment\_awareness}$ should be superior to $T_{assessment\_warning}$.

$T_{assessment\_awareness}$ should provide enough time to the driver for identification of an unexpected situation, detection and decision. According to [15] 4-6 seconds is a relevant and safe timing to let the driver identify an unexpected or unusual situation with more complex decision than only braking (in the case of warning). This timing range is especially appropriate for local hazard, however in the case of crash avoidance use cases these values can be reduced (e.g. 2-4 seconds) to avoid too many false positives/negatives and keep safety benefits for low TTC use cases.

In the case of “no action required”, $T_{potential\_soft\_action\_awareness}$ and $T_{action\_warning}$ would be 0 second. This is the case for example in the dooring scenario where the expectation from the driver is to not open the door as a bicyclist is coming up. It is also relevant in all the use cases where the ego vehicle is stationary, and the expectation is to not start the vehicle (e.g. at an intersection).

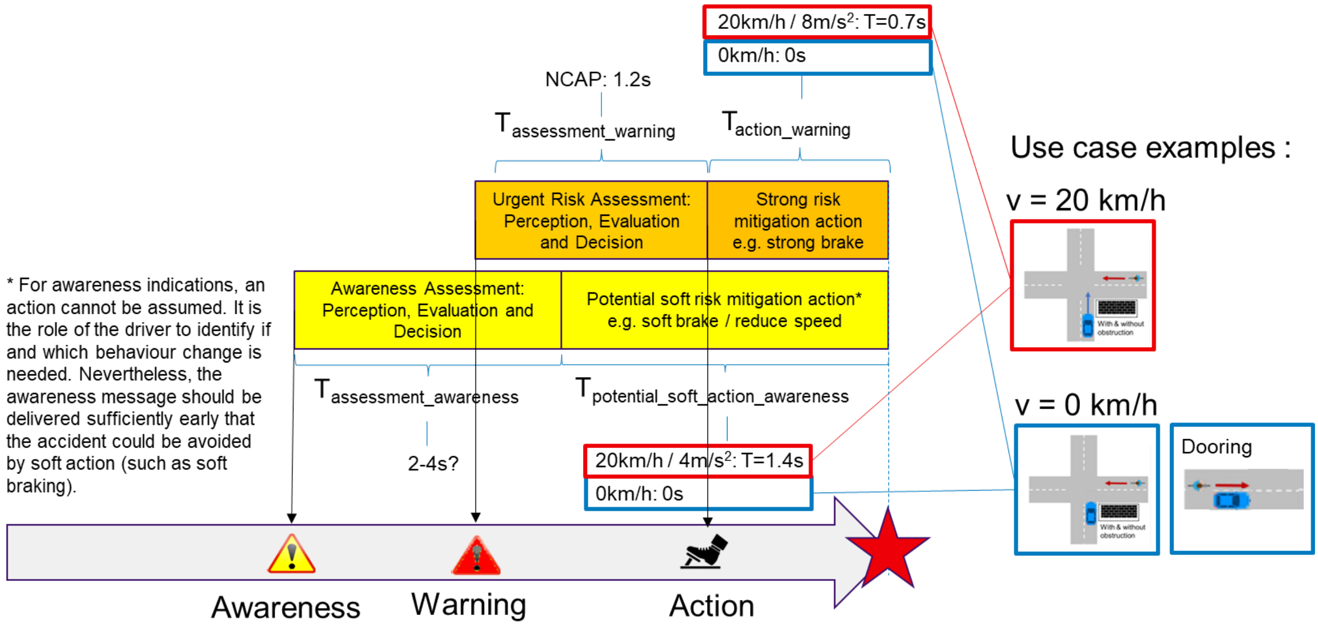


Figure 11 - Awareness and Warning timing methodology (with example parameters)

While implementing driver awareness indications and warnings, the potential of unnecessary (potentially distracting and annoying) awareness indications or false positive warnings should be kept in mind. This is not specially related to V2X, but true for any kind of awareness indication or warning. Driver awareness indications are supposed to be emitted rather early, which increases the potential to be unnecessary and annoying. Therefore, in order to increase acceptance for this feature, measures should be in place to minimize unnecessary awareness indications or warnings. For instance, one could think about only emitting an awareness indication if the onboard sensors do not see the object, e.g., because there is no line of sight, or if additional conditions are fulfilled (e.g. poor visibility conditions, blinding sun etc). In addition, awareness indications should be well implemented in the HMI and not be too intrusive as previously explain in 3.2.3. If this is the case, driver awareness could also not be considered as a false positive.

For the V2X post-crash warning use case, the only relevant countermeasure is to warn the surrounding road users after the accident that there is a danger ahead, on or nearby their estimated vehicle trajectory. The relevant timing is the earliest after the accident. This countermeasure could be directly linked and triggered by passive safety systems.

3.4 Positioning Requirements

Positioning is one of the key requirements for V2X. The accuracy and confidence of this parameter will partly define what can be done with it - or cannot. This concerns the consideration of road user’s types, use cases and different possible countermeasures. The requirements are indeed not at the same level between countermeasures, like e.g., a driver awareness alert and a vehicle action. The positioning expectations are not equal depending on the application and this is also true for countermeasures.

The more precise the expected level of positioning is, the more complex are the means needed to obtain it. It is especially with a data fusion such as Global Navigation Satellite System (GNSS), ego motion, inertial sensors (acceleration, yaw rate), sensors perception (camera, radar, lidar) that a high positioning accuracy level will be reached. However, positioning is not the only element needed to give a prediction of the trajectory and handle different use cases. The other elements could differ between road users; some examples are in the following non-exhaustive list: heading, yaw rate, longitudinal/lateral acceleration, etc.

One significant parameter when speaking of positioning accuracy is the confidence level considered. According to the importance of positioning for V2X and the level of reliability and accuracy expected a 2-sigma (95%) confidence was selected as appropriate.

In general, one can define 4 different levels of positioning accuracy based on the efforts taken to augment GNSS information for higher accuracy, but also availability [12]:

Table 25 – Common levels of positioning accuracy

Level	Description
Basic positioning	"GNSS only", about 10-30m accuracy, providing geo-coordinates only, e.g., used for eCall ("open sky")
Enhanced positioning	"Map matched", about 5-20m accuracy, using map data and dead reckoning to allow route guidance (accuracy mainly depends on map data).
Advanced positioning	"IMU augmented GNSS", about 1.5-5m accuracy, using additional sensor information, giving limited 2D driving lane resolution, improved altitude accuracy.
Precise positioning	"High 3D accuracy", accuracy in cm range, allowing resolution of position within driving lane. Requires advanced methods with real time correction data and advanced sensor fusion

Due to the intended applications and the different environmental conditions of the road network most of the V2X applications require advanced positioning accuracy level.

C2C-CC has also defined 14 different scenarios in its "Basic System Profile" [16] based on the environment (not only considering "open sky"). With these scenarios many of the different environmental factors and challenges for positioning systems should be covered. Based on these different influencing factors a minimal confidence value (C) is defined as a minimal performance requirement for each scenario as summarized in the table 26 below. C2C-CC also has defined how the confidence value has to be measured, as well providing scenario specific accuracy and confidence requirements for heading and speed – as they are also important input parameters for the defined C2C-CC V2X applications.

Table 27 – C2C-CC confidence value (C) by scenarios

Scenario	Minimal Confidence value
Open Sky	C <= 5 m
Tunnel	C <= 15 m
Parking house	Any value is allowed
Half open sky	C <= 7 m
Forest	C <= 10 m
Mountain (valley)	C <= 10 m
City	C <= 14 m
Mild Urban	C <= 10 m

Dynamic driving	C <= 7 m
Static	C <= 5 m
Rough road	C <= 10 m
Icy road	C <= 7 m
High speed	C <= 5 m
Reverse driving	C <= 5 m

For the SECUR use cases “Advance Positioning” accuracy level would be sufficient (both side) for driver awareness and information. Driver warning and vehicle action would require a better accuracy and confidence due to the risk behind these countermeasures. A reliable lane accuracy level is therefore needed.

For post-crash safety “Advance Positioning” accuracy level would be sufficient but lane accuracy would make sense for crash protection.

4. SECUR final Use Cases description

This chapter provides all the information needed to define the SECUR use cases from several points of view: general description, accidentology white spots, V2X description, safety behaviour, SECUR V2X proposal.

For each use case the following information are provided:

- Use case name
- Short name

Use case general description (Based on SECUR WP1 deliverable D1.1 [1] and D1.2 [2])
- Short description
- Pictogram
- Euro NCAP associated scenario
- SECUR use case parameters compared to existing Euro NCAP testing scenario

Proposal to overcome the identified white spots between SECUR accidentology and Euro NCAP scenario (based on SECUR WP3 work)
- SECUR proposal

V2X description (Based on SECUR WP2 deliverables D2.1 [3] and D2.2 [4])
- V2X types considered in the 2026 scope
- V2X requirements
- V2X function (expected)
- V2X messages
- Benefits of V2X
- Relevant connected infrastructure (if relevant)

Safety behaviour (based on SECUR WP3 work)
- Countermeasures

SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)
- SECUR V2X proposal

Table 28 - WP3 and final SECUR use cases summary

Type		Opponent	WP3 N.#	WP3 Use case
SAFETY	Crash avoidance	Passenger car	#3	**SCP-RD Passenger Car** Crossing passenger car from right side at an intersection.
			#7	**SCP-LD Passenger Car** Crossing passenger car from left side at an intersection.
			#10	**RE-FV Passenger Car** Rear-end braking accident between two passenger cars.
			#12a	**LTAP-OD Passenger Car** Passenger car turning left across the path of another vehicle coming from the opposite
			#01	**Head-On Passenger Car** Face to face impact between two passenger cars.
			#12b	**SCP-OD/LTAP Passenger Car** Passenger car going straight at an intersection and having an accident with a vehicle from the opposite direction turning left across its path.
		Powered two wheeler	#13	**LTAP-OD PTW** Passenger car turning left across the PTW path coming from the opposite direction.
			#015	**SCP-LD PTW** Crossing PTW from left side at an intersection.
		Bicyclist	#2	**SCP-RD Bicyclist** Crossing bicyclist from right side at an intersection.
			#9	**SCP-LD Bicyclist** Crossing bicyclist from left side at an intersection.
		Pedestrian	#4	**SCP-RD Pedestrian** Crossing pedestrian from right side.
			#5	**SCP-LD Pedestrian** Crossing pedestrian from left side.
	Safe driving	All	/	**Local Hazard** A situation, an event, or a state towards in which a vehicle is driving.
		None	/	**Red-light violation ego** Ego driver behavior not in line with traffic light status.
		All	/	**Red-light violation opponent** Red light violation of another road user (opponent) at an intersection.
	Post-crash safety	All	/	**V2X post-crash warning** The capability of a vehicle to warn the surroundings road users after an accident.
	Crash protection	All	/	**V2X crash protection (safety opportunity)** Fusion of V2X with pre-crash systems to improve the knowledge of the situation and the

Preliminary notes:

Note: The Critical time/latency V2X requirement refers to all countermeasures even vehicle action. In the case of information, awareness or warning, those timings could be relaxed. The timing corresponds to End-to-End latency.

Note: For each use case the relevant V2X types are listed. However, this is in the 2026 scope. This is important to consider this as the V2X world is changing very fast.

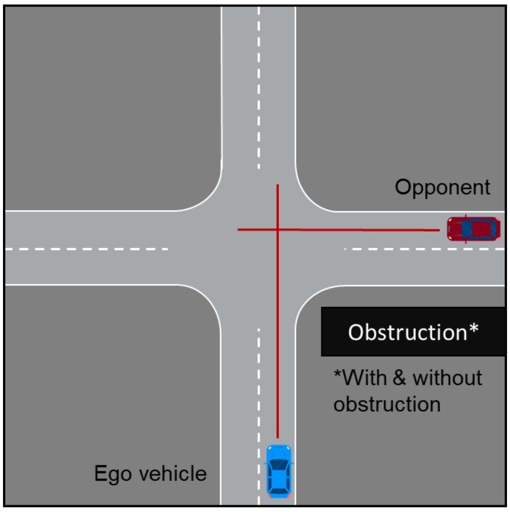
Note: As expressed in SECUR WP2 report D2.2 [4], CPM messages are relevant for some use cases and especially those which could involve connected detection infrastructure. During the project, the publication of official standardisation of CPM messages was not yet validated. The project therefore did not take this type of message into account during its implementation. However, they will remain relevant in the near future for certain use cases.

Note: In all the use cases where the opponent is a PTW, a Bicyclist or a Pedestrian the road users detection infrastructure connected with V2X is required if the VRU is not connected. However, if the opponent is connected the infrastructure is not required, it is then optional and complementary.

Note: For each use cases a comparison is done (as a table) between the SECUR test scenarios parameters highlighted by the accidentology and Euro NCAP ongoing tests.

4.1 USE CASES DESCRIPTION - CRASH AVOIDANCE

4.1.1 STRAIGHT CROSSING PATH – RIGHT DIRECTION [PASSENGER CAR]

Use case name	Straight Crossing Path – Right Direction Passenger Car
Short name	SCP-RD Passenger Car
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Passenger Car A collision in which a vehicle travels forwards along a straight path across a junction, towards a vehicle crossing the junction on a perpendicular path, from the right direction.
Pictogram	

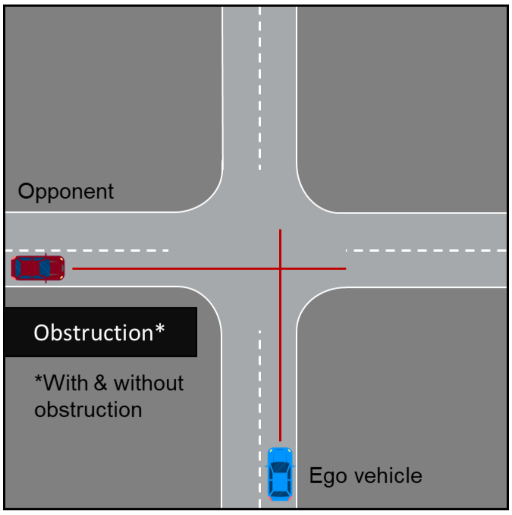
Euro NCAP associated scenario	➢ Car-to-Car Crossing straight crossing path (CCCscp)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

	Euro NCAP CCCscp	SECUR SCP-RD Passenger Car		Comment
Type of test	AEB and FCW	-		
VUT speed (kph)	0 to 60	0 to 60		
VUT direction	Forward	Forward		
Obstruction	No (last 3.5 sec TTC)	No	Yes (structural circumstances)	30% with obstruction and mainly with structural circumstances (e.g. wall, building).
Target direction	Forward	Forward		
Target speed (kph)	20 to 60	0 to 50		0 to 50 kph (86%) 0 to 20 kph (39%)
Impact location (%)	25% of the lenght of GVT	25% of the lenght of GVT		
Light condition	Day	Day	Night	26% during the night / darkness.
Entry in force	2023	-		
Weather	Dry	Dry		
Road geometry	Intersection	Intersection		

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Consider this use case with and without obstruction ➢ Add the range 0 kph to 20 kph to the target speed range ➢ Consider night testing

V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case V2VRU: incompatible with the use case © V2N: relevant to provide complementary information; as well as for countermeasures that do not require low latency (e.g. awareness). © V2I: only relevant to provide complementary information (i.e. a partial answer to the use case)
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages ➢ **V2X emission**: capability of the opponent to send the relevant V2X messages ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM and CPM ➢ Relevant to provide complementary information: MAPEM, SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g., obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✗ **Information**: not relevant ✓ **Awareness**: relevant for mutual presence awareness with conditions on localization (mainly rural) and speed (medium and high speed) ✓ **Warning**: relevant for intersection collision warning ✓ **Action**: relevant for mitigation & crash avoidance by active safety using V2X
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

4.1.2 Straight Crossing Path – Left Direction [Passenger Car]

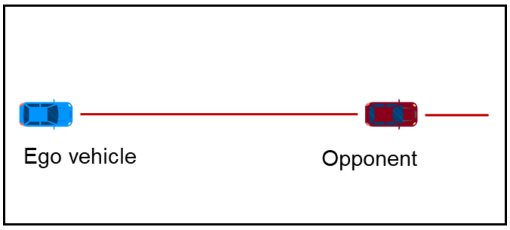
Use case name	Straight Crossing Path – Left Direction Passenger Car
Short name	SCP-LD Passenger Car
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Passenger Car A collision in which a vehicle travels forwards along a straight path across a junction, towards a vehicle crossing the junction on a perpendicular path, from the left direction.
Pictogram	
Euro NCAP associated scenario	➢ Car-to-Car Crossing straight crossing path (CCCscp)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

	Euro NCAP CCCscp	SECUR SCP-LD Passenger Car		Comment
Type of test	AEB and FCW	-		
VUT speed (kph)	0 - 60	0 - 60		
VUT direction	Forward	Forward		
Obstruction	No	No	Yes (structural circumstances)	27% with obstruction and mainly with structural circumstances or other vehicles.
Target direction	Forward	Forward		
Target speed (kph)	20 - 60	5	20 - 60	9% from 0-5 kph 72% from 20-60 kph Interesting to add a low speed tests to complete the accidentology coverage.
Impact location (%)	25% of the lenght of GVT	25% of the lenght of GVT		
Light condition	Day	Day	Night	27% during the night / darkness.
Entry in force	2023	-		
Weather	Dry	Dry		
Road geometry	Intersection	Intersection single lane		

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Consider this use case with and without obstruction ➢ Add a test at 5 kph to the target speed range ➢ Consider night testing

V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case V2VRU: incompatible with the use case © V2N:relevant to provide complementary information; as well as for countermeasures that do not require low latency (e.g. awareness). © V2I: only relevant to provide complementary information (i.e. a partial answer to the use case)
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM and CPM ➢ Relevant to provide complementary information: MAPEM, SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✓ **Awareness**: Relevant for mutual presence awareness with conditions on localization (mainly rural) and speed (medium and high speed). ✓ **Warning**: Relevant for intersection collision warning. ✓ **Action**: Relevant for mitigation & crash avoidance by active safety using V2X.
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

4.1.3 Rear-End – Following Vehicle [Passenger Car]

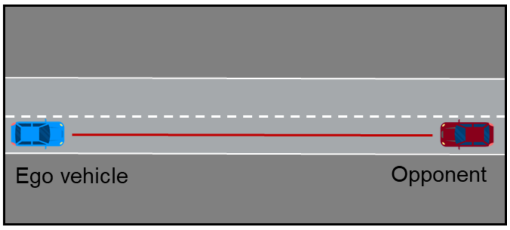
Use case name	Rear-End – Following Vehicle Passenger Car (EEBL)
Short name	**RE-FV Passenger Car**
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Passenger Car A collision in which a vehicle travels forwards towards another vehicle that is travelling in the same direction and the frontal structure of the vehicle strikes the rear structure of the other. From the following vehicle point of view.
Pictogram	
Euro NCAP associated scenario	➢ Car-to-Car Rear Braking (CCRb)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

	Euro NCAP CCRb	SECUR RE-FV PASSENGER CAR		Comment
Type of test	AEB and FCW	-		
VUT speed (kph)	50	50	Higher speeds	8% for speed over 100 kph. 33,5% for speed over 50 kph. Interesting to consider higher speeds.
Obscuration	No	No		
Target direction	Forward	Forward		
Target speed (kph)	50 kph , Headway distance 12 and 40m	50 kph , Headway distance 12 and 40m		
	Deceleration -2 and -6m/s/S	Deceleration -2 and -6m/s/S		
Impact location (%)	100	100		
Light condition	Day	Day	Night	22% during night.
Entry in force	2014	-		
Weather	Dry	Dry		
Road geometry	Straight	Straight		

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Consideration of higher speeds for the ego vehicle ➢ Complete day testing with night testing
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case V2VRU: incompatible with the use case © V2N: relevant to provide complementary information; as well as for countermeasures that do not require low latency (e.g. awareness). ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms

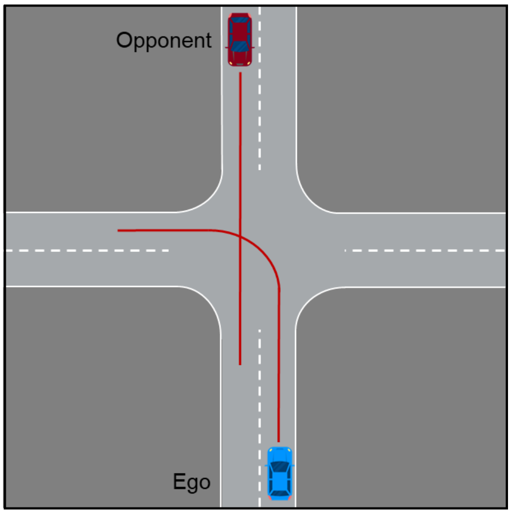
V2X function (Expected)	➢ Emergency Electronic Brake Light (EEBL) Warning / Management Note: "Traffic-jam" and "Sudden Braking Ahead" considered in the use case *Local Hazard*.
V2X messages	➢ Relevant for the use case: DENM, CAM and D2VO ➢ Relevant to provide complementary information: MAPEM and SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Connected Road-Side Unit to broadcast traffic information to the surrounding road users ➢ Connected traffic lights (SPATEM and MAPEM) could add benefits near an intersection
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✘ **Awareness**: Not relevant ✓ **Warning**: Relevant with the Connected Forward Collision Warning (C-FCW) with a condition on the stakeholders' speeds (only high speeds) ✓ **Action**: Relevant for mitigation & crash avoidance by active safety (AEB) using V2X.
Euro NCAP (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing.

4.1.4 Head-On [Passenger car]

Use case name	Head-On Passenger Car
Short name	/
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Passenger Car A collision where a vehicle is travelling along a straight path and strikes another vehicle travelling in the opposite direction.
Pictogram	
Euro NCAP associated scenario	➢ CCFhos (= Car-to-Car Front Head-On Straight) ➢ CCFhol (= Car-to-Car Head-On Lane change)
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case V2VRU: incompatible with the use case ✘ V2N: not relevant for the use case ✘ V2I: not relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Collision Warning / Management ➢ Overtaking Warning / Management Note: “wrong way driving” local Hazard not in this use case but in the Local Hazard one.
V2X messages	➢ Relevant for the use case: CAM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	No relevant infrastructure
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Relevant but not in this use case as covered by Local Hazard in Safe Driving Euro NCAP rating scheme with wrong way driving. ✓ **Awareness**: Relevant for mutual presence awareness with the condition that the street have at least two circulation directions. ✓ **Warning**: Relevant for forward collision warning with the condition that the street have at least two circulation directions. ✓ **Action**: Relevant for mitigation & crash avoidance by active safety using V2X.

SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing.

4.1.5 Left Turn Across Path – Opposite Direction [Passenger Car]

Use case name	Left Turn Across Path – Opposite Direction Passenger Car
Short name	LTAP-OD Passenger Car
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Passenger Car A collision in which a vehicle turns across the path of an oncoming vehicle, and the frontal structure of the vehicle strikes the front structure of the other.
Pictogram	
Euro NCAP associated scenario	➢ Car-to-Car Front turn-across-path (CCFtap)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

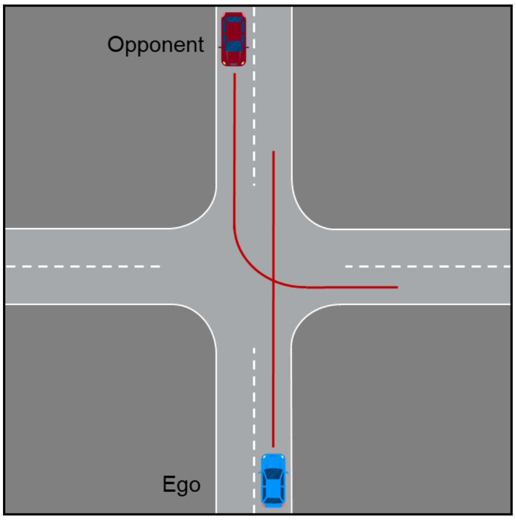
SECUR Use case parameters compared to existing Euro NCAP scenario:

	Euro NCAP CCFtap	SECUR LTAP-OD Passenger Car	Comment
Type of test	AEB	-	
VUT direction	Farside turn	Farside turn	
VUT speed (kph)	10, 15, 20	0 - 40	42% from 0 - 20 kph 86% from 0 to 40 kph Lower and higher speeds interesting to complete the accidentology coverage.
Obstruction	No	No	
Target direction	Straight	Straight	
Target speed (kph)	30, 45, 60	30, 45, 60	
Impact location (%)	50% of the VUT on 10% of GVT width	50% of the VUT on 10% of GVT width	
Light condition	Day	Day	
Entry in force	2020 (2023)	-	
Weather	Dry	Dry	
Road geometry	Intersection	Intersection	

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Consideration of lower and higher speeds for the ego vehicle

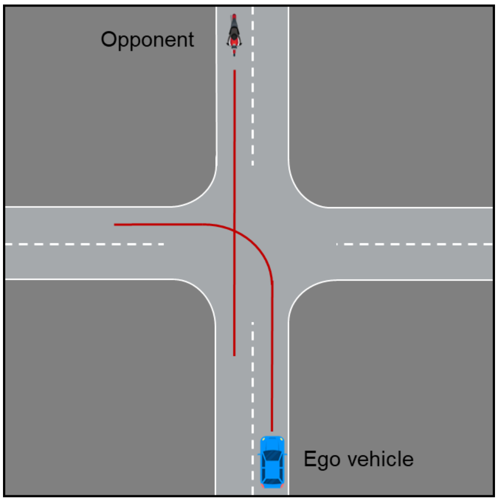
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case V2VRU: incompatible with the use case © V2N: only relevant to provide complementary information (i.e. a partial answer to the use case) ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent or/and a connected detection infrastructure to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM and CPM ➢ Relevant to provide complementary information: MAPEM and SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✘ **Awareness**: Not relevant ✘ **Warning**: Not relevant ✓ **Action**: Relevant for mitigation & crash avoidance by active safety (AEB) using V2X.
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing.

4.1.6 Straight Crossing Path – Opposite Direction and Left Turn Across Path [Passenger Car]

Use case name	Straight Crossing Path – Opposite Direction and Left Turn Across Path Passenger Car
Short name	SCP-OD/LTAP Passenger Car
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Passenger Car A collision in which a vehicle travels forwards along a straight path across a junction, towards a vehicle coming from the opposite direction and turning left across the path of the ego vehicle. The frontal structure of the vehicle strikes the front structure of the other.
Pictogram	
Euro NCAP associated scenario	➢ Similar to Car-to-Car Front turn-across-path (CCFtap), but from the other point of view.
SECUR Use case parameters compared to existing Euro NCAP scenario	Same table than the SECUR use case LTAP-OD Passenger Car with an inversion of the other points of view.
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case V2VRU: incompatible with the use case © V2N: only relevant to provide complementary information (i.e. a partial answer to the use case) ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent or/and a connected detection infrastructure to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM and CPM ➢ Relevant to provide complementary information: MAPEM and SPATEM

Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: not relevant ✘ **Awareness**: not relevant ✘ **Warning**: not relevant ✓ **Action**: relevant for mitigation & crash avoidance by active safety (AEB) using V2X.
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing.

4.1.7 Left Turn Across Path – Opposite Direction [PTW]

Use case name	Left Turn Across Path – Opposite Direction PTW
Short name	**LTAP-OD PTW**
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: PTW A collision in which a vehicle turns across the path of an oncoming motorcycle, and the frontal structure of the vehicle strikes the front structure of the other.
Pictogram	
Euro NCAP associated scenario	➢ Car-to-Motorcycle Front turn-across-path (CMFtap)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

	Euro NCAP CMFtap	SECUR LTAP-OD PTW	Comment
Type of test	AEB	-	
VUT speed (kph)	10, 15, 20	0 - 30	81% from 0-30 kph Lower and higher speeds interesting to complete the accidentology coverage.
VUT direction	Farside turn	Farside turn	
Obstruction	No	No	
Target direction	Straight	Straight	
Target speed (kph)	30, 45, 60	30, 45, 60	
Impact location (%)	50	50	
Light condition	Day	Day / Night	23% during night.
Entry in force	2023	-	
Weather	Dry	Dry	
Road geometry	Intersection	Intersection	

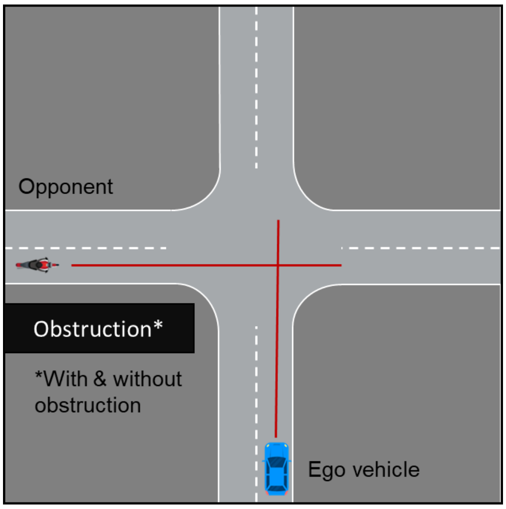
Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Extend the ego vehicle speed to 0-30 kph to cover relevant lower and higher speeds ➢ Complete day testing with night testing
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✗ V2V: not relevant for the use case ✓ V2VRU: relevant for the use case © V2N: relevant to provide complementary information; as well as for

	countermeasures that do not require low latency (e.g. awareness). ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent or/and a connected detection infrastructure to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ VRU Warning / Protection ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM and CPM ➢ Relevant to provide complementary information: MAPEM and SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: not relevant ✓ **Awareness**: relevant ✘ **Warning**: not relevant ✓ **Action**: relevant for mitigation & crash avoidance by active safety (AEB) using V2X.
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing.

4.1.8 Straight Crossing Path – Left Direction [PTW]

Use case name	Straight Crossing Path – Left Direction PTW
Short name	SCP-LD PTW

Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])

Short description	Ego vehicle: Passenger Car Opponent: PTW A collision in which a vehicle travels forwards along a straight path across a junction, towards a PTW crossing the junction on a perpendicular path, from the left direction.
Pictogram	
Euro NCAP associated scenario	➢ Car-to-Motorcycle Crossing (CMC)

SECUR Use case parameters compared to existing Euro NCAP scenario

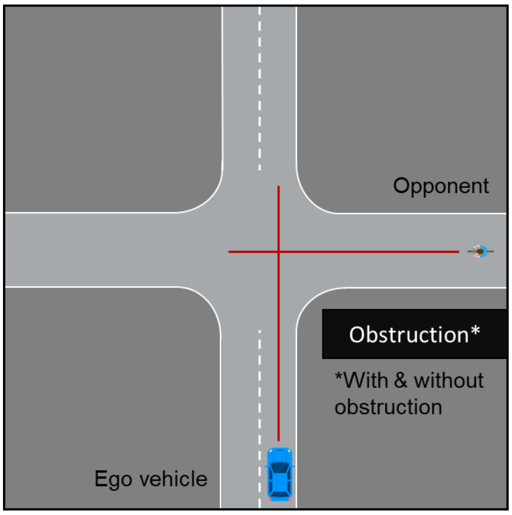
	Euro NCAP **CMC** (defined by MUSE project)	**SECUR** **SCP-LD PTW**		**Comment**
Type of test	AEB	-		
VUT speed (kph)	10-15-20	0 - 20		41% in 0-5 kph 18% in 6-10 kph 87% in 0-20 kph Add low speed testing interesting to complete the accidentology coverage.
VUT direction	Straight	Straight		
Obstruction	No	No	Yes (vehicles)	43% with obstructionv(mainly vehicles).
Target direction	Straight	Straight		
Target speed (kph)	30, 40, 50	30 - 60		73% in 31-60 kph 13% in 50-60 kph Interesting to extend the speed range to 60 kph.
Impact location (%)	25% of the lenght of VUT	25% of the lenght of VUT		
Light condition	Day	Day		
Entry in force	-	-		
Weather	Dry	Dry		
Road geometry	intersection	Intersection		

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario

Identified white spots between accidentology and Euro NCAP scenario	➢ Consider ego vehicle low speed (0 to 10 kph). ➢ Consider obstruction (with vehicles) ➢ Expend the target speed range to 60 kph

V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✘ V2V: not relevant for the use case ✓ V2VRU: relevant for the use case © V2N: relevant to provide complementary information; as well as for countermeasures that do not require low latency (e.g. awareness). ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent and/or a connected VRU detection infrastructure (V2I) to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ VRU Warning / Protection ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM and CPM ➢ Relevant to provide complementary information: MAPEM and SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✓ **Awareness**: Relevant for mutual presence awareness ✓ **Warning**: Relevant for intersection collision warning ✓ **Action**: Relevant for mitigation & crash avoidance by active safety using V2X
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

4.1.9 Straight Crossing Path – Right Direction [Bicyclist]

Use case name	Straight Crossing Path – Right Direction Bicyclist
Short name	SCP-RD Bicyclist
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Bicyclist A collision in which a vehicle travels forwards along a straight path across a junction, towards a bicyclist crossing the junction on a perpendicular path, from the right direction.
Pictogram	
Euro NCAP associated scenario	➢ Car-to-Bicyclist Nearside Adult (CBNA) ➢ Car-to-Bicyclist Nearside Adult Obstructed (CBNAO)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

SECUR Use case parameters compared to existing Euro NCAP scenario

	Euro NCAP Coverage		**SECUR**		**Comment**
	CBNA	**CBNAO**	**SCP-RD$_{BICYCLE}$**		
Type of test	AEB		/		
VUT speed (kph)	10 - 60		0 - 60		0 to 10 (42,3%) Interesting to add low speed (0-10kph)
VUT direction	Forward		Forward		
Obstruction	No	Yes (parked vehicles)	No	Yes (structural circumstances)	35% with obstruction and mainly structural circumstances (e.g. building). Replace parked vehicles by a more complete obstruction like a wall / fake wall.
Target direction	From nearside		From nearside (reduction of the distance between bicyclist and obstruction)		According to SECUR and CATS projects' accidentology the distance of the bicyclist to the obstruction should be reduced.
Target speed (kph)	15	10	5 & 15		83% with a target speed from 5 to 20 kph in SECUR. According to SECUR and CATS accidentology the bicyclist speed should be increased to 15. 5kph should be added to include very low opponent speed.
Impact location (%)	50		50		
Light condition	Day		Day		
Entry in force	2020		/		
Weather	Not defined		Dry		
Road geometry	Not defined but based on distance it's similar to an intesection		Intersection		

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario

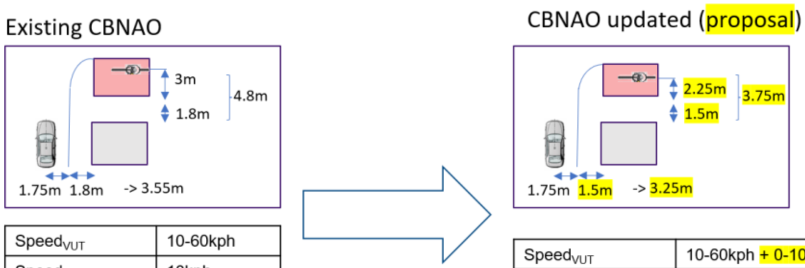
SECUR proposal

The aim of this SECUR proposition is to update the existing CBNAO scenario to make it more realistic of accidents and more challenging for the actual systems. This update of CBNAO is not only focusing on AEB but on all active systems (including AEB and V2X).

Note: On the pictogram the horizontal dotted central line is not drawn to allow more flexibility to the bicyclist position on the road.

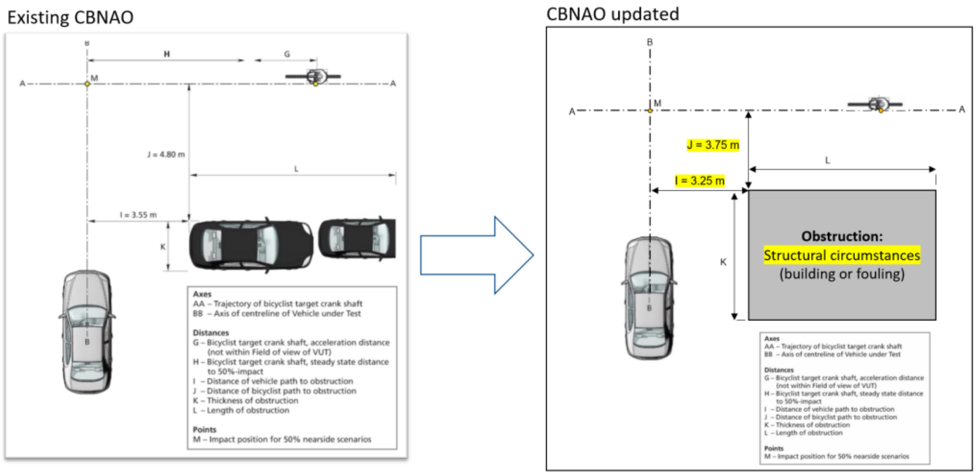
PARAMETER	VALUE	UPDATE EXPLANATION
$Speed_{VUT}$	10-60kph + 0-10kph	The today's protocol miss the range 0-10kph which is very important in the accidentology of this scenario. → **SECUR proposal is to include this range to the existing one.**
$Speed_{Target}$	~~10kph~~ → 5 & 15kph	The initial speed recommended by CATS project was 15kph according to the accidentology. This is also confirmed by SECUR work. In addition, low speed is an important part and should not be forgotten. → **SECUR proposal is to add 5 kph as target speed** → **SECUR proposal to increase the speed from 10kph to 15kph of the target to be more representative of real accidents.**
$Distance_{lat}$ Distance between the Passenger Car and the obstruction	~~3.55m~~ →3.25m	In CATS project the following range was given 2.95m<D lat<3.55m. For feasibility reason and as first step for the scenario, Euro NCAP took the value of 3.55m. → **SECUR proposal is to decrease the lateral distance between the vehicle and the obstruction. The proposed value is the mean between the MIN_{lat} and MAX_{lat} value proposed by CATS.** MIN_{lat} (= 1.75 + 1.2 = 2.95m) < D lat < MAX_{lat} (= 1.75+1.8=3.55m)
$Distance_{long}$ Distance between the Bicycle and the obstruction	~~4.8m~~ →3.75m	In CATS project the following range was given 2.7m<D long<4.8m. For feasibility reason and as first step for the scenario, Euro NCAP took the value of 4.8m. → **SECUR proposal is to decrease the longitudinal distance between the Bicyclist and the obstruction. The proposed value is the mean between the MIN_{long} and MAX_{long} value proposed by CATS.** MIN_{long} (= 1.2 + 1.5 = 2.7m) < D long < MAX_{long} (= 1.8+3=4.8m)
Impact location	50%	No change
Obstruction type	~~Vehicle~~ → Building	According to CATS and SECUR project the obstruction type should be more similar to building than vehicle. → **SECUR proposal is to change the obstruction type.**

Table 29 - Summarize of the SECUR proposal and explanation by parameter



$Speed_{VUT}$	10-60kph
$Speed_{Target}$	10kph
$Distance_{lat}$	3.55m
$Distance_{long}$	4.8m
Impact location	50%
Obstruction type	Vehicle

$Speed_{VUT}$	10-60kph + 0-10kph
$Speed_{Target}$	~~10kph~~ → 15kph
$Distance_{lat}$	~~3.55m~~ →3.25m
$Distance_{long}$	~~4.8m~~ →3.75m
Impact location	50%
Obstruction type	~~Vehicle~~ → Building

	Figure 12 - Pictograms and CBNAO parameters tables to illustrate the SECUR proposal based on its accidentology and CATS project [17]  *Figure 13 - Proposal of the Euro NCAP pictogram update*
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✘ V2V: not relevant for the use case ✓ V2VRU: relevant for the use case © V2N:relevant to provide complementary information; as well as for countermeasures that do not require low latency (e.g. awareness). ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the opponent (V2N or V2VRU) or/and a connected detection infrastructure (V2I) to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ VRU Warning / Protection ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: CAM/VAM, DENM and CPM ➢ Relevant to provide complementary information: MAPEM and SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g., obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: not relevant ✓ **Awareness**: relevant for mutual presence awareness ✓ **Warning**: relevant for intersection collision warning ✓ **Action**: relevant for mitigation & crash avoidance by active safety using V2X
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

4.1.10 Straight Crossing Path – Left Direction [Bicyclist]

Use case name	Straight Crossing Path – Left Direction Bicyclist
Short name	SCP-LD Bicyclist

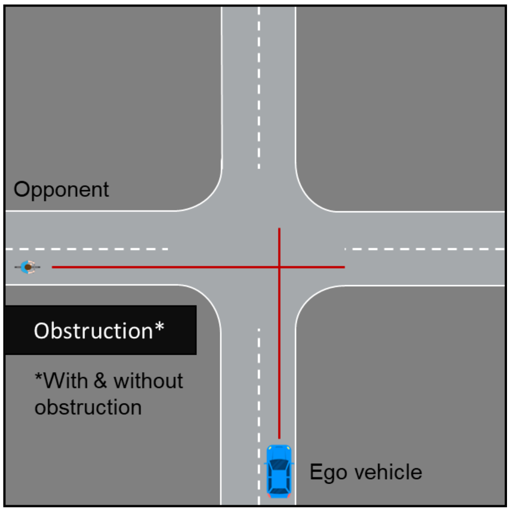
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])

Short description

Ego vehicle: Passenger Car
Opponent: Bicyclist

A collision in which a vehicle travels forwards along a straight path across a junction, towards a bicyclist crossing the junction on a perpendicular path, from the left direction.

Pictogram



Euro NCAP associated scenario

- Car-to-Bicyclist Farside Adult (CBFA)

SECUR Use case parameters compared to existing Euro NCAP scenario

	Euro NCAP CBFA	SECUR SCP-LD BICYCLE		Comment
Type of test	AEB	-		
VUT speed (kph)	10 - 60	0 - 60		0 to 10 (31%) Interesting to add low speed (0-10kph)
VUT direction	Forward	Forward		
Obstruction	No	No	Yes	30% with obstruction and mainly structural circumstances.
Target direction	From farside	From farside		
Target speed (kph)	20	10, 20		92% from 6 to 25 kph 19% from 6 to 10 kph Add a low speed test at 10 kph interesting to complete the accidentology coverage.
Impact location (%)	50	50		
Light condition	Day	Day		
Entry in force	2020	-		
Weather	Dry	Dry		
Road geometry	Intersection	Intersection		

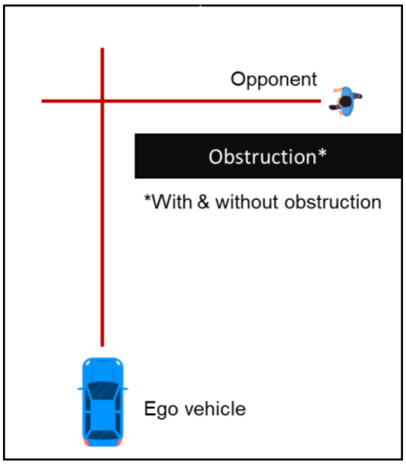
Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario

SECUR proposal

- Consider ego vehicle low speed (0 to 10 kph).
- Consider obstruction
- Add 10 kph in the target speeds

V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✘ V2V: not relevant for the use case ✓ V2VRU: relevant for the use case © V2N: relevant to provide complementary information; as well as for countermeasures that do not require low latency (e.g. awareness). ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability for the opponent (V2N or V2VRU) and/or connected detection infrastructure (V2I) to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ VRU Warning / Protection ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: DENM, CAM/VAM and CPM ➢ Relevant to provide complementary information: MAPEM and SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✓ **Awareness**: Relevant for mutual presence awareness ✓ **Warning**: Relevant for intersection collision warning ✓ **Action**: Relevant for mitigation & crash avoidance by active safety using V2X
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

4.1.11 STRAIGHT CROSSING PATH – RIGHT DIRECTION [PEDESTRIAN]

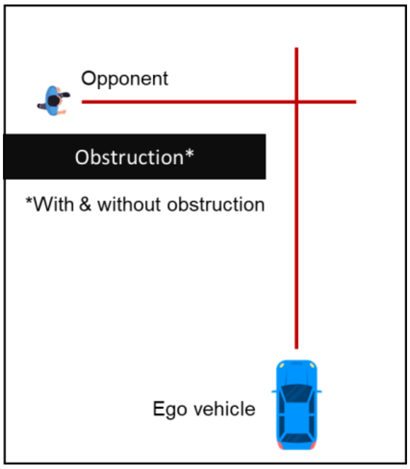
Use case name	Straight Crossing Path – Right Direction Pedestrian
Short name	SCP-RD Pedestrian
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Pedestrian A collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian.
Pictogram	
Euro NCAP associated scenario	➢ Crossing Pedestrian Nearside Adult (CPNA) Note: The Euro NCAP Car-to-Pedestrian Nearside Child Obstructed (CPNCO) scenario could also be associated but it is not the focus of this SECUR use case. However, its data are available for information in the table below.
SECUR Use case parameters compared to existing Euro NCAP scenario	See table below

	Euro NCAP		SECUR		Comment
	CPNA (adult)	CPNCO (child)	SCP-RD Pedestrian (adult)		
Type of test	AEB		-		
VUT speed (kph)	10 - 60		10 - 60		
VUT direction	Forward		Forward		
Obstruction	No	Yes	No	Yes (vehicles)	39% with obstruction and mainly with vehicles.
Target direction	From nearside		From nearside		
Target speed (kph)	5		5		
Impact location (%)	50	25 and 75	50		
Light condition	Day and Night (night not tested for RADAR only system)		Day and Night (night not tested for RADAR only system)		
Entry in force	2016		-		
Weather	Dry		Dry		
Road geometry	Straight road		Straight road		Mainly straight road (otherwise before/after intersection)

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Consider obstruction in this scenario
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	

V2X types considered in the 2026 scope	✘ V2V: not relevant for the use case ✘ V2VRU: not relevant for the use case ✘ V2N: not relevant for the use case ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of a connected detection infrastructure to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ VRU Warning / Protection ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: DENM, CAM/VAM and CPM. ➢ Relevant to provide complementary information: MAPEM, SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✓ **Awareness**: Relevant for VRU presence awareness with conditions on localization (mainly rural) and speed (medium and high speed). ✓ **Warning**: Relevant for intersection collision warning. ✓ **Action**: Relevant for mitigation & crash avoidance by active safety using V2X.
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

4.1.12 Straight Crossing Path – Left Direction [Pedestrian]

Use case name	Straight Crossing Path – Left Direction Pedestrian
Short name	SCP-LD Pedestrian
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: Pedestrian A collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the farside and the frontal structure of the vehicle strikes the pedestrian.
Pictogram	
Euro NCAP associated scenario	➢ Crossing Pedestrian Farside Adult (CPFA)
SECUR Use case parameters compared to existing Euro NCAP scenario	(see table below)

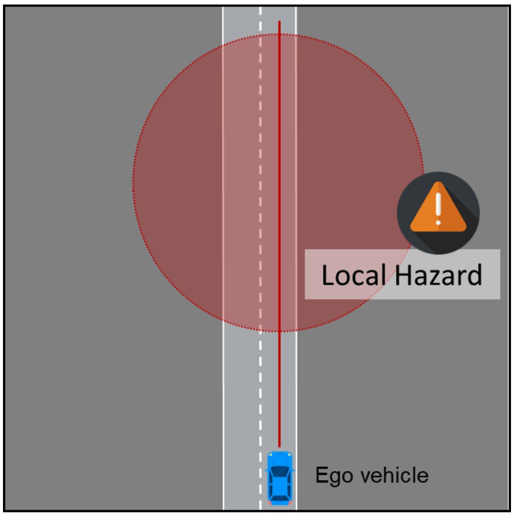
	Euro NCAP CPFA		SECUR SCP-LD Pedestrian		Comment
Type of test	AEB		-		
VUT speed (kph)	10 - 60		10 - 60		
VUT direction	Forward		Forward		
Obstruction	No		No	Yes (vehicles)	40% with obstruction and mainly with other vehicles.
Target direction	From farside		From farside		
Target speed (kph)	8		8		
Impact location (%)	50		50		
Light condition	Day	Night	Day	Night	
Entry in force	2016 and updated in 2023		-		
Weather	Dry		Dry		
Road geometry	Straight road		Straight road		Mainly straight road (otherwise before/after intersection)

Proposal to overcome the Identified white spots between SECUR accidentology and Euro NCAP scenario	
SECUR proposal	➢ Consider obstruction (type = vehicle) in this scenario
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✘ V2V: not relevant for the use case ✘ V2VRU: not relevant for the use case ✘ V2N: not relevant for the use case ✓ V2I: relevant for the use case

V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of a connected detection infrastructure to send the relevant V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ VRU Warning / Protection ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: DENM, CAM/VAM and CPM ➢ Relevant to provide complementary information: MAPEM, SPATEM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	➢ Road users' detection infrastructure connected with V2X ➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✓ **Awareness**: Relevant for VRU presence awareness at conditions on localization (mainly rural) and speed (medium and high speed). ✓ **Warning**: Relevant for intersection collision warning. ✓ **Action**: Relevant for mitigation & crash avoidance by active safety using V2X.
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in the considered and assessed safety systems of the Euro NCAP associated use case during testing. A specific focus should be done on scenarios with obstruction considering that there is an overlap between obstructed and non-obstructed ones. Additionally, this is where V2X is the most valuable and will bring fast and significant benefits.

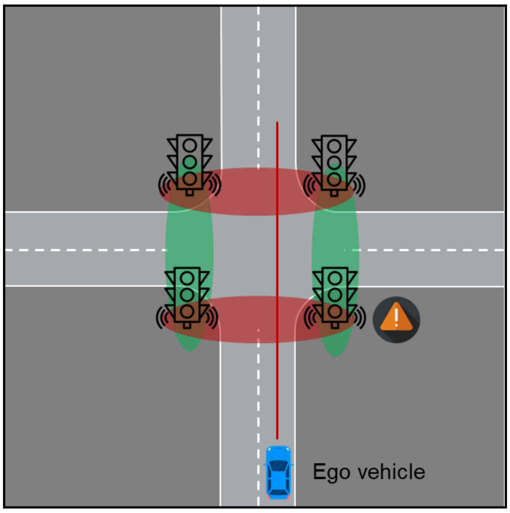
4.2 USE CASES DESCRIPTION – SAFE DRIVING

4.2.1 LOCAL HAZARD

Use case name	Local Hazard
Use case general description (based on SECUR WP1 Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: There is no opponent for this use case. A situation, an event, or a state towards in which a vehicle is driving. The aim of local Hazard is to provide information to the driver for a safe and comfort drive. V2X bring data on the road state to the driver, so he could adapt his behaviour in consequence. A local hazard can be very diversified, below a non-exhaustive list: ➢ Sudden braking ahead ➢ Dangerous end of queue ➢ Traffic jam ➢ Roadworks ➢ Accident Ahead ➢ Emergency vehicle ➢ Stationary vehicle ➢ Poor road conditions (inc. slippery roads) ➢ Adverse weather conditions (includes for, precipitation, snow, etc) ➢ Wrong way driver ➢ Items on road (includes animals, persons, debris, etc) ➢ VRU on road (includes bicyclist, pedestrian, etc) ➢ etc
Pictogram	
Euro NCAP associated scenario	➢ Speed Assist System (SAS)
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case ✓ V2VRU: relevant for the use case ✓ V2N: relevant for the use case ✓ V2I: relevant for the use case

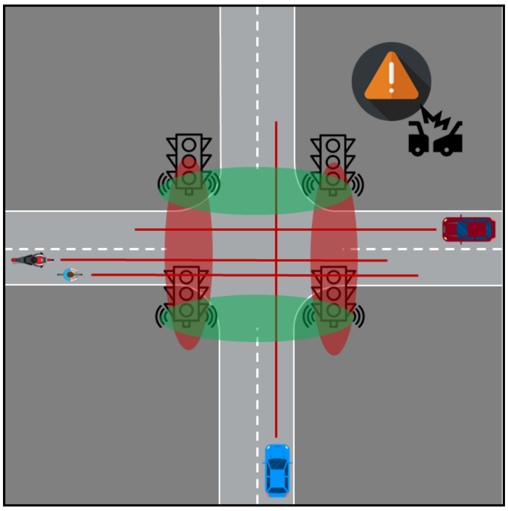
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the ecosystem (all connected road users, connected infrastructures and network-based solution) to analyse and broadcast the relevant information through V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Local Hazard Warning / Management
V2X messages	➢ Relevant for the use case: DENM ➢ Relevant to provide complementary information: CAM
Benefits of V2X	➢ Provide additional information to the driver for a safer and more comfort drive. ➢ Facilitate a better driver anticipation.
Relevant connected infrastructure	➢ Connected Road-Side Unit to broadcast traffic information to the surrounding road users
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✓ **Information**: Relevant according to each specific local hazard requirements ✓ **Awareness**: Relevant according to each specific local hazard requirements ✓ **Warning**: Relevant according to each specific local hazard requirements ✗ **Action**: Not relevant
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Set up tests to assess the capability of a vehicle to trigger, send, receive and display to the driver alerts correctly.

4.2.2 Red-Light Violation EGO

Use case name	Red-Light Violation
Use case general description (Derived from SECUR WP1 work, Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: No opponent Situation in which a vehicle travels forwards along a straight path across a junction with traffic lights. If its behaviour is not in line with the traffic lights status a driver alert will prevent from a red-light violation.
Pictogram	
Euro NCAP associated scenario	➢ Speed Assist System (SAS)
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	V2V: incompatible with the use case V2VRU: incompatible with the use case ✓ V2N: relevant for the use case ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: capability of the traffic light infrastructures to broadcast its traffic information (traffic light current state and timings before switching) through V2X messages. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Red-light Violation Warning / Management
V2X messages	➢ Relevant for the use case: SPATEM and MAPEM
Benefits of V2X	➢ Provide additional information to the driver for a safer and more comfort drive. ➢ Facilitate a better driver anticipation.
Relevant connected infrastructure	➢ Connected traffic lights
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✗ **Information**: Not relevant ✓ **Awareness**: Relevant

	✓ **Warning**: Relevant ✗ **Action**: Not relevant
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Add V2X in red-light violation ego tests to assess the capability of a vehicle to receive, treat and display to the driver the relevant information.

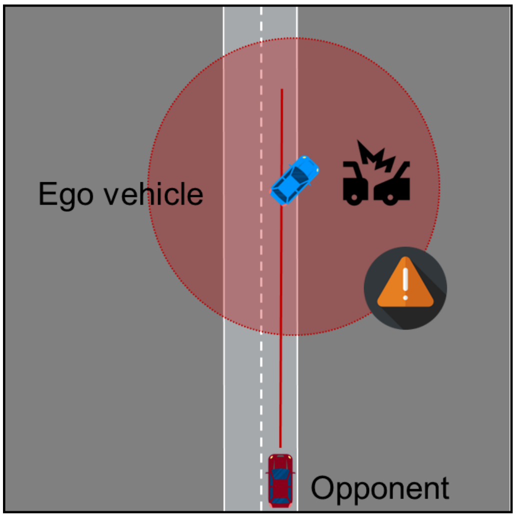
4.2.3 Red-Light Violation Opponent

Use case name	Red-Light Violation
Use case general description (Derived from SECUR WP1 work, Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: All road users This use case is a complement of the red-light violation and comes in addition of the elements described in the previous table. Situation in which a vehicle travels forwards along a straight path across a junction with traffic lights and a road user do a red-light violation. This use case allows the connected ecosystems (connected infrastructures and connected road users) to alert and share information about another road user red-light violation to the ego vehicle.
Pictogram	
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case ✓ V2VRU: relevant for the use case ✓ V2N: relevant for the use case ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability of the ego vehicle to receive and treat the relevant V2X messages. ➢ **V2X emission**: o capability of the traffic light infrastructures to broadcast its traffic information (traffic light current state and timings before switching) through V2X messages. o capability of the connected ecosystem to send red-light violation information when necessary. ➢ **Critical time/latency**: 100ms
V2X function (Expected)	➢ Red-light Violation Warning / Management ➢ Intersection Collision Warning / Management
V2X messages	➢ Relevant for the use case: DENM, SPATEM, MAPEM and CAM
Benefits of V2X	➢ Provide additional information to the driver/safety systems: V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g. obstruction) and can therefore complement the amount, type and reliability of information.

Relevant connected infrastructure	➢ Connected traffic lights ➢ Connected Road-Side Unit to broadcast traffic information to the surrounding road users ➢ Road users' detection infrastructure connected with V2X
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: Not relevant ✘ **Awareness**: Not relevant ✓ **Warning**: Relevant ✓ **Action**: Relevant
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Set up a red-light violation opponent test to assess the capability of a vehicle to receive, treat, display and act in this scenario.

4.3 USE CASES DESCRIPTION – POST-CRASH SAFETY

4.3.1 V2X POST-CRASH WARNING

Use case name	V2X Post-Crash Warning
Use case general description (Derived from SECUR WP1 work, Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: All road users This use case allows the ego vehicle after an accident to alert the surrounding road users and to create a V2X virtual dangerous area around the accident.
Pictogram	
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case ✓ V2VRU: relevant for the use case ✓ V2N: relevant for the use case ✓ V2I: relevant for the use case
V2X requirements	➢ **V2X reception**: capability for the surrounding road users to receive, treat the V2X messages and display the relevant information to the driver. ➢ **V2X emission**: capability of the ego vehicle to alert the surrounding road users through V2X messages during and after an accident. These messages could be triggered by passive safety systems. ➢ **Critical time/latency**: the best latency is around 100ms (or less) for a very effective effect and prevention on the closest other road users. However, a V2X system without this low latency capability will still be very effective over the entire duration of the risk (except during the accident).
V2X function (Expected)	➢ Post-Crash Warning / Management
V2X messages	➢ Relevant for the use case: DENM, CAM and CPM
Benefits of V2X	➢ Provide new information to the surrounding vehicle (driver and safety systems): creation of a V2X virtual dangerous area to prevent from additional accidents.
Relevant connected infrastructure	➢ Connected Road-Side Unit (or traffic sign) to broadcast the accident information to the surrounding road users

Safety behaviour (based on SECUR WP3 work)	
Countermeasures	Post-crash only
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	Integrate V2X in passive safety testing to evaluate the capability of a vehicle to alert the surroundings road users when this one has an accident, to prevent from additional accidents.

4.4 USE CASES DESCRIPTION – CRASH PROTECTION (SAFETY OPPORTUNITY)

4.4.1 V2X CRASH PROTECTION (SAFETY OPPORTUNITY)

This use case is defined as a safety opportunity in SECUR as it was not part of the work and not studied specifically.

Use case name	V2X Crash protection
Use case general description (Derived from SECUR WP1 work, Deliverable D1.1 [1] and D1.2 [2])	
Short description	Ego vehicle: Passenger Car Opponent: All road users A use case in which the ego vehicle detects an unavoidable crash. The ego vehicle is preparing, triggering pre-crash systems to protect the passengers during the crash and warning the surrounding road users. The objective is to support pre-crash systems with new information coming from V2X - as a new sensor to improve the knowledge of the situation and the effectiveness. Example of the existing pre-crash systems, pre-emption of: ➢ Throttle ➢ Brakes ➢ Window control (closure of the window)
Pictogram	Crash Protection: Fusion of V2X with Pre-Crash systems to improve the knowledge of the situation and the effectiveness. Preemption of pre-crash (Throttle, brakes, window control, etc.) systems to mitigate the crash.
V2X description (based on SECUR WP2 Deliverable D2.1 [3] and D2.2 [4])	
V2X types considered in the 2026 scope	✓ V2V: relevant for the use case ✓ V2VRU: relevant for the use case ✘ V2N: not relevant for the use case ✓ V2I: relevant for the use case
V2X requirements	➢ **Ego**: ○ capability of the ego vehicle to receive, treat V2X messages and support pre-crash systems with new V2X inputs. ○ capability of the vehicle to broadcast a pre-crash state in the V2X messages. ➢ **Opponent**: ○ capability to send the relevant V2X messages. ○ capability to broadcast a pre-crash state in the V2X messages (if possible, depends on the road user).

	➢ **Critical time/latency**: 50ms
V2X function (Expected)	➢ Pre-crash data exchange
V2X messages	➢ Relevant for the use case: CAM, DENM and CPM
Benefits of V2X	➢ Provide additional information to the driver/pre-crash systems to improve the knowledge of the situation and the suitability of the safety system answer. V2X as an additional sensor. V2X is not affected by the same limitations as current sensors (e.g., obstruction) and can therefore complement the amount, type and reliability of information.
Relevant connected infrastructure	Infrastructure not relevant for this case
Safety behaviour (based on SECUR WP3 work)	
Countermeasures	✘ **Information**: not relevant ✘ **Awareness**: not relevant ✘ **Warning**: not relevant ✓ **Action**: relevant
SECUR proposal for the V2X integration into Euro NCAP 2030 roadmap (based on SECUR WP3 work)	
SECUR V2X proposal	No specific proposal on this use case

CONCLUSION

This report (D3.1) is the key WP3 deliverable. Firstly, it described the ADAS and V2X literature review performed to summarize the characteristics of ADAS focusing on their limits, effectiveness and presenting the V2X opportunities. Secondly, the discussions that have led to the SECUR final use cases selection were synthesised. Thirdly, the final use cases list derived from the WP1 use cases were described. This deliverable is based on accidentology information coming from WP1 [1] [2], connectivity inputs coming from WP2 [3] [4]) and from the work of the WG3.

The OSCCAR project was reviewed and provided accident data and ADAS performance inputs. OSCCAR project [9] analysed the effect of different safety solutions, including ADAS, and was considered to validate the SECUR accident scenarios coming from the accidentology (based on frequency and severity). As shown in Conclusion between the results and SECUR2.1.4, SECUR findings are in line with the ones from OSCCAR.

Besides the positive impact ADAS have on injuries mitigation and accidents avoidance, they are now facing their technological and physical limits in order to be improved. V2X is a key answer to push those limits since it is not subject to the same constraints. Besides the potential benefit of V2X technology, its readiness also needs to address several challenges before it is widely deployed.

The links between WP1 accident scenarios and the final SECUR use cases were described. These final ones are derived from at least one WP1 use case, sometimes several, or even all. The final SECUR use cases belong to the three following Euro NCAP rating schemes: crash avoidance, safe driving and post-crash safety. However, SECUR considers also crash protection as a V2X safety opportunity, but however no studies were performed on this one.

To mitigate these crashes the following V2X based countermeasures were defined: "driver information", “driver awareness”, “driver warning”, “vehicle action”, “pre-crash” and “post-crash”. The use cases were assigned to these countermeasures. This report also describes a proposed methodology to define when it is relevant to trigger a driver awareness and/or warning alert.

Positioning is one of the key requirements for V2X. The accuracy and confidence of this parameter will partly define what can be done with it - or cannot. This concerns the consideration of road user’s types, use cases and different possible countermeasures. The requirements are indeed not at the same level between countermeasures, like e.g., a driver awareness alert and a vehicle action. The positioning expectations are not equal depending on the application and this is also true for countermeasures. For the SECUR use cases “Advance Positioning” accuracy level would be sufficient (on both sides) for driver awareness. Driver warning and vehicle action would require a better accuracy and confidence due to the risk behind these countermeasures. A lane accuracy level is therefore at least needed.

Above all, the main part of this report precisely defines the final selection of the SECUR use cases list considering several aspects: general description, accidentology, connectivity, safety behaviour and SECUR proposal for the V2X integration at Euro NCAP.

Following SECUR, remaining studies will need to be done or further developed. Firstly, the subject of HMI and how to provide accurate information, at the right time, to the driver without confusing and disrupting him while providing the best safety benefits. Secondly, the positioning topic around V2X and the accuracy/confidence requirements for every application or road user should be further studied. Some other project or consortium are also working on this subject. Thirdly, the SECUR use cases presented in this report are the main use cases identified based on severity and frequency on the road. However, V2X could bring benefits in many other cases. In addition, the use cases will be able to become more complex with the democratisation of V2X and its improvement.

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Partners

Contributors

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TABLE OF ILLUSTRATIONS