SECUR

Safety Enhancement through Connected Users on the Road

Test and Assessment Proposals

WP5 – Deliverable D5.1

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Introduction

INTRODUCTION

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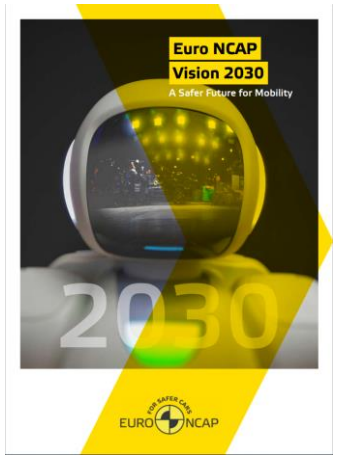
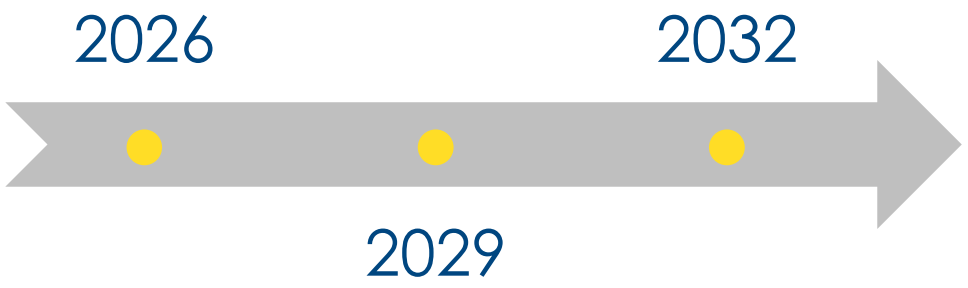
- **The objective of this document is to propose to Euro NCAP a SECUR view on the way to test and assess V2X in test protocols.** This document is complementary of the SECUR V2X roadmap.
- SECUR propose to include V2X in 4 rating schemes:
  - Safe driving
  - Post-crash safety
  - Crash avoidance
  - Crash protection (V2X as a safety opportunity - annex)





- In this proposal, **V2X** should mostly be considered as **an additional sensor**.
- The **proposed assessment methodology is different between "Safe driving/Post-crash safety" and "Crash avoidance"**. Safe driving/Post-crash safety assessment is more on a **"pass/fail" mode**. While Crash avoidance methodology sticks to the **existing assessment methodology of systems' performance** (impact/impact speed) with the addition of a step involving V2X.
- This document does not provide points distribution or precise test speed combinations.

V2X requirements

V2X REQUIREMENTS

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Connected vehicle requirements

- **The vehicle must be registered to an open ecosystem** (not proprietary). This implies the validation of very detailed and various criteria, e.g., cover data quality, PKI (Public Key Infrastructure) security, GDPR, capability to send/receive, etc.
  Today, an example for direct communication (V2V, V2I, V2VRU) is the European Certificate Trust list (ECTL). For indirect communication (V2N), a solution should be developed in the upcoming years, which allows to have trustable data. Ideally, all these ecosystems (direct and indirect communication and cloud-based solution) should be connected.
- **The vehicle must perform the test with V2X security (PKI) activated**.
  If it is not possible for testing to use the production PKI platform, Euro NCAP/Lab could create their own PKI dedicated to testing. Vehicle Under Test (VUT) will thus have to register it before testing.

Connected testing environment requirements

- The V2X link between the target and the vehicle should be validated before testing to ensure that there is no communication issue.
- The goal of V2X testing is not to test the vehicle technical communication performance (e.g., communication range, antenna pattern/sensibility) but the application safety performance. For this reason, the following communication KPIs must be guaranteed on the testing grounds.
  - Direct communication:
    - Packet Error Rate (PER) should be lower than 10% in a range of 300 m (between the target and a reference vehicle/device).
    - Channel Busy Ratio (CBR) should be lower than 40%.
  - Indirect communication:
    - Standard communication availability should be ensured with a value higher than [subject to precise in the future]
- The connected target should comply with the SECUR V2X specifications (Deliverable 4.1).
- V2X data logging during the test.

Crash Avoidance

Assessment methodology

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Background

- **V2X** should be considered as **an additional sensor**.
- List of **countermeasures** defined and considered in SECUR for crash avoidance (definitions in annex):
  - **Driver awareness**,
  - **Driver warning**,
  - **Non-safety-critical vehicle action**
  - **Safety-critical vehicle action**

KEY IDEA of the assessment method proposed by SECUR

Even with the availability of connectivity in vehicles, it is necessary to continue conventional ADAS development to **tackle accidents with unconnected vehicles and ensure system effectiveness.** The effectiveness of connectivity is indeed **dependent on market penetration.**

CRASH AVOIDANCE
OVERALL ASSESSMENT METHODOLOGY

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KEY IDEA of the assessment method proposed by SECUR

Even with the availability of connectivity in vehicles, it is necessary to continue conventional ADAS development to **tackle accidents with unconnected vehicles and ensure system effectiveness.** The effectiveness of connectivity is indeed **dependent on market penetration.**

Main assessment proposal

- OEM **shall choose** to perform specific Euro NCAP **tests with or without connectivity**, i.e., with or without connected target.
- Following the KEY IDEA above, **a vehicle is rewarded with less points if a test is passed/mitigated with connectivity**. Indeed, in this case, the test success is achieved due to the connected opponent, yet connectivity cannot be expected for every road user in the near future due to progressive market penetration.
- This new test possibility will **allow a vehicle to pass/mitigate scenarios or speed combinations not currently covered without connectivity**. In this case, not full but partial score will be awarded.
- With the proposed methodology, the OEM chooses whether to use V2X for the safety countermeasures. *See SECUR roadmap for more detail on the V2X test introduction proposal.*

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Euro NCAP scenarios

- SECUR makes the difference between two scenario types, **scenarios possible with on-board sensors only** and those **difficult/not possible with on-board sensors only** (implicit need of V2X by design).
- Today, the second type is not present at Euro NCAP, but this may change is the future.
- Over time, new and updated scenarios will complete the Euro NCAP testing catalog. Scenarios could move from a type to the other one.
- SECUR proposes also a second assessment method for the second type of scenarios: "**difficult/not possible with on-board sensors only".** Both methods are presented on the next slide. Those high-level methodologies should be fine tune for each relevant crash avoidance test scenario.

→ Next slides present a diagram of the proposed assessment methodologies.

CRASH AVOIDANCE
OVERALL ASSESSMENT METHODOLOGIES

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SCENARIO TYPES

Scenarios possible with on-board sensors only	Scenarios NOT possible/difficult with on-board sensors only (Implicit need of V2X by design)

ASSESSMENT METHODS

Main assessment method

OEM's choice by test case (e.g. speed combination)

OEM Choice 1:
Non-connected test, i.e., with a non-connected target (V2X function switched off).
*Pass = full points (**100%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 2:
Connected test, i.e., with a connected target (V2X function switched on)
*Pass = part of the points, less than choice 1 (**100% -X_A%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 3:
Availability and performance of driver awareness (V2X function switched on)
*Pass = part of the points, less than choice 2 (**100% -X_B%; X_B>X_A**)*

Secondary assessment method

OEM's choice by test case (e.g. speed combination)

OEM Choice 1:
Connected test, i.e., with a connected target (V2X function switched on)
*Pass = full points (**100%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

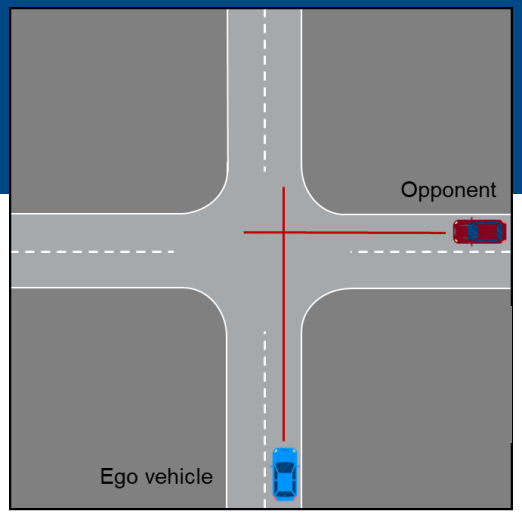
OEM Choice 2:
Availability and performance of driver awareness (V2X function switched on)
*Pass = part of the points, less than choice 1 (**100% -X_C%**)*

Driver Awareness*:
In relevant situations, a clear and effective HMI should communicate the right information to the driver (e.g., direction and type of risk). Additional Points (few) if the VUT is fitted with driver awareness.

Main assessment method

*: The identification of driver awareness relevant situations is a challenge. Further investigations will be required to determine when and how driver awareness should be raised.

EXAMPLE 1
CCCscp – 2026



Test parameters

	CCCscp (2026)
Connected systems assess	AEB & FCW & Awareness (it is the choice of the OEM to use or not V2X as an additional sensors
VUT speed (kph)	0-60
VUT direction	Forward
Obstruction	No
Target speed (kph)	20-60
Impact location (%)	25% of GVT length
Light condition	Day
Number of test	Complementary of exiting ADAS (today, Min:0, Max: 30)

→ OEM **shall choose** to perform test cases **with or without connectivity**, i.e., with or without connected target.

SCENARIO TYPES

Scenarios possible with on-board sensors only

ASSESSMENT METHODS

Main assessment method

OEM's choice by test case (e.g. speed combination)

OEM Choice 1:
Non-connected test, i.e., with a non-connected target (V2X function switched off).
*Pass = full points (**100%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

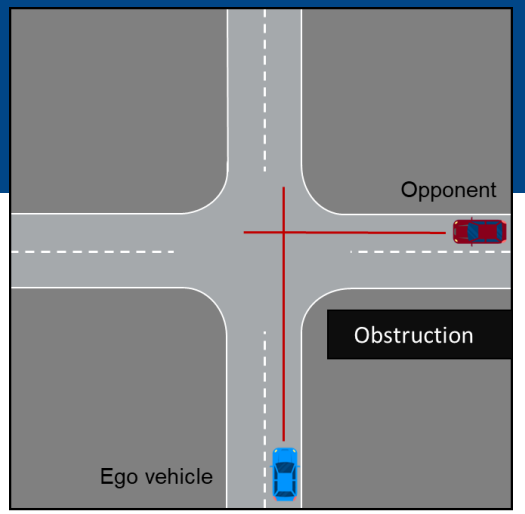
OEM Choice 2:
Connected test, i.e., with a connected target (V2X function switched on)
*Pass = part of the points, less than choice 1 (**100% -X_A%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 3:
Availability and performance of driver awareness (V2X function switched on)
*Pass = part of the points, less than choice 2 (**100% -X_B%**)*

Driver Awareness*:
In relevant situations, a clear and effective HMI should communicate the right information to the driver (e.g. direction and type of risk). Additional Points (few) if the VUT is fitted with driver awareness.

EXAMPLE 2
CCCscpO – 2026



Test parameters

	CCCscpO (2026)
Connected systems assess	AEB & FCW & Awareness (it is the choice of the OEM to use or not V2X as an additional sensors
VUT speed (kph)	0-60 (not yet defined at Euro NCAP)
VUT direction	Forward
Obstruction	Yes
Target speed (kph)	20-60 (not yet defined at Euro NCAP)
Impact location (%)	25% of GVT length
Light condition	Day
Number of test	Complementary of exiting ADAS (today, Min:0, Max: 30)

→ OEM **shall choose** to perform test cases **with or without connectivity**, i.e., with or without connected target.

SCENARIO TYPES

Scenarios NOT possible/difficult with on-board sensors only (Implicit need of V2X by design)

ASSESSMENT METHODS

Secondary assessment method

OEM's choice by test case (e.g. speed combination)

OEM Choice 1:
Connected test, i.e., with a connected target (V2X function switched on)
*Pass = full points (**100%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 2:
Availability and performance of driver awareness (V2X function switched on)
*Pass = part of the points, less than choice 1 (**100% -X_C%**)*

Driver Awareness*:
In relevant situations, a clear and effective HMI should communicate the right information to the driver (e.g. direction and type of risk). Additional Points (few) if the VUT is fitted with driver awareness.

EXAMPLE
ILLUSTRATION OF THE OEM CHOICE WITH THE MAIN ASSESSMENT METHOD

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→ OEM **shall select one choice (below) for every test case** to be performed by Euro NCAP.

Choice 1: *without V2X (V2X function switch off, on the target)*

1. Vehicle action test (AEB or non-safety-critical vehicle action (NSC-VA)). If the test is fulfilled (passed/mitigated), all points are awarded for this test case. FCW score is also awarded automatically when the vehicle action shows collision avoidance.
2. FCW test without V2X (V2X function switch off, on the target) for the required speed combinations (only if vehicle action test failed). If the test is fulfilled (passed/mitigation), points (i.e., less than with vehicle action) are awarded for the specific speed combination.

→ **If the vehicle performance for some test cases do not allow to pass/mitigate the crash with vehicle action and/or FCW system without V2X, connected test could be the choice of the OEM (see choice 2).**

Choice 2: *with V2X (V2X function switch on, on the target)*

1. Vehicle action tests (AEB or NSC-VA). If the test is fulfilled (passed/mitigated), part of the points (less than in choice 1) are awarded for this specific test case. FCW score is also awarded automatically when the vehicle action shows collision avoidance.
2. FCW test for the required test case (only if vehicle action with V2X test failed). If a test is fulfilled (passed/mitigated), points (i.e., less than choice 1) are awarded for the test case.

→ **If the vehicle performance do not allow to mitigate the crash for some test cases with connected vehicle action and/or FCW systems, see choice 3.**

Choice 3: *with V2X (V2X function switch on, on the target)*

Driver awareness test with V2X for the required speed combinations. Driver awareness should happen before the minimum timing required to be rewarded with part of the point (i.e., less than for choice 2).

Examples:

OEM 1:

VUT	GVT				
	20 km/h	30 km/h	40 km/h	50 km/h	60 km/h
Start from stop	AEB	AEB	AEB	AEB	AEB
20 km/h	AEB	AEB	AEB	AEB	AEB
30 km/h	AEB	AEB	AEB	AEB	AEB
40 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW
50 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW
60 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW

OEM 2:

VUT	GVT				
	20 km/h	30 km/h	40 km/h	50 km/h	60 km/h
Start from stop	AEB	AEB	AEB	AEB	AEB
20 km/h	AEB	AEB	AEB	AEB	AEB
30 km/h	AEB	AEB	AEB	AEB	AEB
40 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW
50 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW
60 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW

Choice 1: Non-connected test (vehicle action and FCW)

Choice 2: Connected test (vehicle action and FCW)

Choice 3: Connected test (Driver awareness)

Safe Driving

Assessment methodology

- **Local hazard is not a new topic at Euro NCAP**. It is already considered in the “Speed Assist System (SAS)” rating scheme.

- **Today at Euro NCAP:**
  - Only “reception” is considered.
  - There is not systematic testing. The evaluation is based on a dossier and a basic control is done during an open road test.
  - Consideration of 9 Local Hazards with two required actions: inform and warn.

- The following **SECUR proposal comes in addition to the existing** and propose mainly elements to “Safe driving” but also one to “Post-crash safety” rating schemes.

4.4.2.3 Local Hazards

Systems that are able to receive messages and process them to warn for local hazards before the come within the field of view of the vehicle forward looking sensors can attract points for the features implemented. The possible features to select from are listed in the table below.

The information / warning referring to these conditions may be shown separately from the speed limit information requested in the general requirements (Section 4.4.1).

The hazard information/data could either be provided by vehicle-integrated devices or by mobile devices physically connected to the vehicle network (provided in all cases by standard vehicle-integrated driver interfaces). A list of compatible devices needs to be mentioned in the vehicle handbook.

LOCAL HAZARDS	Points
Traffic Jams	2
Construction Zones	1
Accident Ahead	1
Wrong Way Driver	1
Stopped Vehicle on Hard Shoulder	1
Items on road (includes animals, persons, debris, etc)	1
Poor Road Conditions (incl. slippery roads)	1
Poor Weather Conditions (e.g. fog, heavy rain, etc)	1
Emergency Vehicle	1
TOTAL	10

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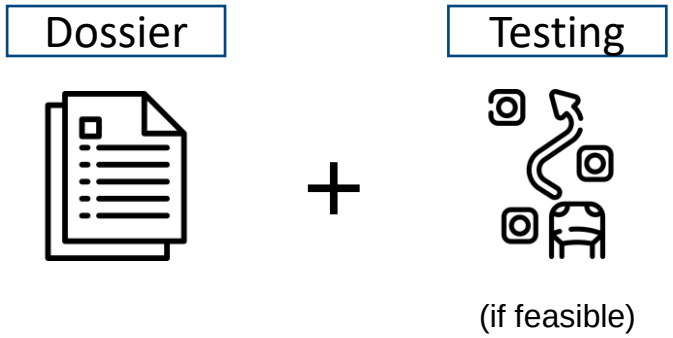
Proposal

- OEM should provide a **dossier** about the vehicle local hazards features**, how they were validated/tested by the OEM** and **how Euro NCAP could replicate these validations/tests** (if feasible).
- **The dossier and tests should cover the receiving and sending sides**. It is indeed important that a vehicle can receive and send information with regards to local hazards to maximize the safety benefit.
- Triggering conditions for the sending side of direct communication are already proposed by groups, i.e., C2C-CC and C-ROADS. For cloud-based solutions, these triggering conditions may not apply, the dossier should be used as basis for assessment.
- Slide 20 presents a preliminary table for direct communication describing local hazards testing methods (sending and receiving side). However, it is important to highlight that it is not as straightforward to test all implemented solutions (e.g. cloud-based).



SAFE DRIVING
LOCAL HAZARDS LIST

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The existing Euro NCAP local hazards list, was detailed and enriched with V2X groups' work.

Euro NCAP rating scheme	V2X Profile* availability	Local hazard
Safe driving	Yes (Dangerous situation)	**Electronic Emergency Brake light (EEBL)** (i.e. Heavy brake)
	Yes (Traffic jam)	**Dangerous end of queue** (i.e. end of traffic jam)
		Traffic jam ahead
	Yes (Emergency vehicle)	**Emergency vehicle in operation**
		Stationary safeguarding emergency vehicle (i.e. safeguards a stationary hazard area)
		Stationary recovery service warning (i.e. broken-down vehicle support)
	Yes (Roadwork)	**Roadwork**
	None / Not yet defined	**Wrong way driver**
		Item on road (i.e. animals, debris, etc)
		VRU on road (i.e. bicyclist, pedestrian, etc)
	Yes (Adverse weather condition)	**Fog**
		Precipitation
		Traction loss (i.e. slippery road)
	Yes (Stationary vehicle)	**Stopped vehicle**
		Broken-down vehicle
Safe driving & Post crash safety		**Post-crash warning**

*: A Profile provides the same understanding of a set of parameters. Indeed, even if C-ITS stations follow the same standard, there is still a lot of room for interpretation that lead to the impossibility to specific alerts. Profile are needed to have interoperable systems. Groups like C2C-CC and C-ROADS have defined and described Profiles and the local hazard necessary triggering conditions.

For example, C2C-CC has defined most of the selected local hazards for direct communication with their triggering conditions in detail. These documents should be used by OEMs to make sure that all vehicles understand each other and are interoperable.

Today, C2C-CC is the main source for V2V local hazards triggering conditions and C-ROADS for V2I local hazards triggering conditions.

SAFE DRIVING
PRELIMINARY TABLE FOR DIRECT COMMUNICATION

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			Sending side				Receiving side				
Euro NCAP rating scheme	**V2X Profile* availability**	**Local hazard**	**Assessment** track testing / open road / dossier	**Testability difficulty** simple / medium / difficult	**Testing methodology***	**Required action**	**Assessment** track testing / open road / dossier	**Testability difficulty** simple / medium / difficult	**Testing methodology**	**Required action**	**Assessment criteria**
Safe driving	Yes (Dangerous situation)	**Electronic Emergency Brake light (EEBL)** (i.e. Heavy brake)	Track testing	Simple	Drive the vehicle and apply a emergency breaking.	Trigger and send the relevant V2X message(s)	Track testing	Simple	Evaluation of this function during an Rear-end braking test with a connected target.	Vehicle countermeasures at the OEM's choice	Pass/Fail (One test required for the sending side and for the receiving side)
	Yes (Traffic jam)	**Dangerous end of queue** (i.e. end of traffic jam)	Track testing (or dossier)	Simple	Simulation of the relevant traffic situation on-track.				Virtual generation of local hazard on-track.		
		Traffic jam ahead									
	Yes (Emergency vehicle)	**Emergency vehicle in operation**	Incompatible with passenger car, only send by emergency vehicle.								
		Stationary safeguarding emergency vehicle (i.e. safeguards a stationary hazard area)									
		Stationary recovery service warning (i.e. broken-down vehicle support)									
	Yes (Roadwork)	**Roadwork**	2026: No test 2029: Track testing (or open road)	2026: / 2029: Simple	*(2026: only send by connected infrastructure.* *2029: also sent by vehicle.)*						
	None / Not yet defined	**Wrong way driver**	Track testing (or dossier)	Simple	*Drive the vehicle on a one-way road in the opposite direction.*						
		Item on road (i.e. animals, debris, etc)	2026: No test 2029: Track testing	2026: / 2029: Simple	*(2026: only send by connected infrastructure.* *2029: also sent by vehicle.)*						
		VRU on road (i.e. bicyclist, pedestrian, etc)									
	Yes (Adverse weather condition)	**Fog**	Dossier (or open road)	Difficult	/						
		Precipitation	Dossier (or open road)	Medium	/						
		Traction loss (i.e. slippery road)	Track testing	Simple	Trigger a traction loss on a low adherence zone.						
	Yes (Stationary vehicle)	**Stopped vehicle**	Track testing	Simple	Drive the vehicle, then stop it, put the warning light and open the door (or wait 30 seconds).				Drive the vehicle while another connected vehicle is stationary along the road. Or, the local hazard could be generated virtually on-track.		
		Broken-down vehicle	Dossier	Difficult	/						
Safe driving & Post crash safety		**Post-crash warning**	Track testing	Simple	Evaluation of this function during a passive safety test. The same methodology as for e-call could be applied.				Virtual generation of local hazard on-track.		

*: A **Profile** provides the same understanding of a set of parameters. Indeed, even if C-ITS stations follow the same standard, there is still a lot of room for interpretation that lead to the impossibility to specific alerts. Profile are needed to have interoperable systems. Groups like C2C-CC and C-ROADS have defined and described Profiles and the local hazard necessary triggering conditions.

Post-crash safety

Assessment methodology

POST-CRASH WARNING
ADDITIONAL EXPLANATIONS

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Today at Euro NCAP:

- Post-crash warning (V2X) is not existing at Euro NCAP today.

SECUR Proposal:

- The objective of the “Post-crash warning” application is to evaluate the capability of a vehicle to warn the surrounding road users when this one has an accident. The aim is to prevent from additional accidents.
- Evaluation of this function during a passive safety test. The same methodology as for e-call could be applied.
- C2C-CC proposed triggering conditions; RS 2003 – Stationary vehicle – Post-crash

			Sending side				Receiving side				
Euro NCAP rating scheme	**V2X Profile* availability**	**Local hazard** Driver information / awareness / warning	**Assessment** track testing / open road / dossier	**Testability difficulty** simple / medium / difficult	**Testing methodology***	**Required action**	**Assessment** track testing / open road / dossier	**Testability difficulty** simple / medium / difficult	**Testing methodology**	**Required action**	**Assessment criteria**
Safe driving & Post crash safety	Yes (Stationary vehicle)	**Post-crash warning**	Track testing	Simple	Evaluation of this function during a passive safety test. The same methodology as for e-call could be applied.	Trigger and send the	Track testing	Simple	Virtual generation of local hazard on-track.	Vehicle countermeasures at the OEM's choice	Pass/Fail (One test required for the sending side and for the

*: A **Profile** provides the same understanding of a set of parameters. Indeed, even if C-ITS stations follow the same standard, there is still a lot of room for interpretation that lead to the impossibility to specific alerts. Profile are needed to have interoperable systems. Groups like C2C-CC and C-ROADS have defined and described Profiles and the local hazard necessary triggering conditions.

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Annex

Crash Protection

Assessment methodology

Safety opportunity

CRASH PROTECTION
Safety opportunity

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Safety opportunity (not studied in SECUR):

- V2X required.
- Use of V2X to improve the knowledge of the accident and the surrounding, in the case of a potential collision detected by ego or opponent on-board sensors.
- Based on C2C-CC RS 2004 – Exchange of IRC.
  This document describes the triggering conditions for a critical driving situation where V2X specific messages should be exchanged with the potential collision opponents of potential collision opponents shall be exchanged.
  Those messages are called Impact Reduction Containers (IRCs).

				Sending side				Receiving side				Assessment criteria Only one test required
Euro NCAP rating scheme	**V2X Profile* availability**	**V2X application**	**SECUR Roadmap step**	**Assessment** track testing / open road / dossier	**Testability difficulty** simple / medium / difficult	**Testing methodology*** V2X messages logging with a connected device	**Required action**	**Assessment** track testing / open road / dossier	**Testability difficulty** simple / medium / difficult	**Testing methodology**	**Required action**	
Crash protection	Exchange of Impact Reduction Containers (IRC)	**Exchange of vehicles' data for a critical driving situation where a crash between two vehicles is highly likely or unavoidable.** (Request & Respond)	2029	Track testing (or dossier)	Simple	Evaluation of this application during a crash avoidance test (e.g AEB test - CCCscp). Target should not resquest IRC data.	Trigger and send the relevant V2X message(s) to send its vehicle data and request the opponent data.	Track testing (or dossier)	Simple	Evaluation of this application during a crash avoidance test (e.g AEB test - CCCscp). However, target should be the first to send and resquest IRC data.	Respond by sending it own vehicle data	Pass / Fail

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SECUR V2X roadmap

SECUR countermeasures[1]:

- Driver Information (DI)[2]: 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 (DA)[3]: 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 (DW): 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). V2X could be used as an additional sensor.
- Vehicle Action: Mitigation and crash avoidance by active safety systems. V2X could be used as an additional sensor. According to SECUR, it might not be possible to rely on V2X for ASIL level applications before 2029. The Vehicle Action category could be divided between Non-safety-critical and Safety-critical actions:
  - Non-safety-critical Vehicle Action (NSC-VA) **is not subject to ASIL requirements due to the low consequence severity**. V2X is very relevant to reinforce quickly (2026) these applications' type (e.g., speed reduction, acceleration limitation, system parameter/sensitivity update, etc.)
    Non-safety-critical vehicle actions combined with V2X are already sufficient to have a quick impact on road safety.
  - Safety-critical Vehicle Action (SC-VA) **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).

LEGEND

[1]: SECUR definition based on ETSI C-ITS model.
[2]: Driver Information only matches "Safe driving" scenarios but not "Crash avoidance" ones based on TTC relevance.
[3]: The impact of the DA on safety has not been deeply analyzed in SECUR, especially the impact of too much information and the way to prioritize it very close to a potential hazardous situation.

V2X ROADMAP

		2026	OUTLOOK 2029	2032
V2X INTEGRATION AND COUNTERMEASURES (all rating schemes)	CAR-TO-CAR	Countermeasures: **DI / DA / DW* / NSC-VA***	**+ SC-VA***	
	CAR-TO-PTW	Countermeasures: **DI / DA / DW* / NSC-VA***	**+ SC-VA***	
	CAR-TO-BC	Countermeasures: **DI / DA**	**+ DW* / NSC-VA* / SC-VA***	
	CAR-TO-PD		Countermeasures: **DI / DA / DW* / NSC-VA* / SC-VA***	
POSSIBLE V2X TYPES IN EURO NCAP RATING SCHEMES	Crash Avoidance	**V2V / V2N / V2VRU**	**+ V2I**	
	Safe Driving	**V2V / V2N / V2VRU / V2I**		
	Post-crash Safety	**V2V / V2N / V2VRU / V2I**		
	Crash Protection (safety opportunity)		**V2V / V2N / V2VRU**	
ROAD ECOSYSTEM CONNECTIVITY LEVEL FORECAST	Passenger Car	**Available**	**Available**	
	PTW	**Initially available**	**Available**	
	Bicyclist	**Initially available**	**Available**	
	Pedestrian	**Not available**	**Initially available**	**Available**
	Infrastructure	**Initially available**	**Available** (for specific use cases)	

LEGEND

DI: Driver Information
DA: Driver Awareness
DW: Driver Warning

NSC-VA: Non-Safety-Critical Vehicle Action
SC-VA: Safety-Critical Vehicle Action
PTW: Powered-Two-Wheelers

BC: Bicyclist
PD: Pedestrian
* : V2X could be used as an additional sensor for warning and action

V2X ROADMAP

Scenario format: Euro NCAP Scenario (SECUR scenario)

LEGEND

PTW: Powered-Two-Wheelers
BC: Bicyclist
PD: Pedestrian

DI: Driver Information
DA: Driver Awareness
DW: Driver Warning
NSC-VA: Non-Safety-Critical Vehicle Action
SC-VA: Safety-Critical Vehicle Action

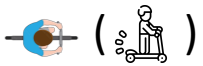
[1]: V2X could be used as an additional sensor for warning and action

[2]: C-ITS day 1 - Described in C2C-CC and C-ROADS Triggering conditions documents

[3]: To be defined in a later stage (not in SECUR scope).

[4]: Extension of the previous step with the consideration of additional, more critical scenarios and countermeasures.

[5]: Use a soft-landing process.

	2026	OUTLOOK 2029[4]	2032[4]
CRASH AVOIDANCE			
CAR-TO-CAR	**DA / DW[1] / NSC-VA[1]** STEP 1 • CCCscp (#3&7 SCP-LD or RD) • CCRb (#10 RE-FV) → EEBL[2] • CCCscpO (#3&7 SCP-LD or RD)[5]	**+ SC-VA[1]** STEP 2 • CCFtap (#12 LTAP-OD) • CCFhol & CCFhos (#01 Head-on)	STEP 3 • Additional/Advance Use Cases not defined yet[3]
CAR-TO-PTW	**DA / DW[1] / NSC-VA[1]** STEP 1 • CMCscp (#15 SCP-LD)	**+ SC-VA[1]** STEP 2 • CMCscpO (#15 SCP-LD) • CMFtap (#13 LTAP-OD)	STEP 3 • Additional/Advance Use Cases not defined yet[3]
CAR-TO-BC 	**DA** STEP 1 • CBNAO (#2 SCP-RD) • CBFAO (#9 SCP-LD)	**+ DW[1] / NSC-VA[1] / SC-VA[1]** STEP 2 • CBTA • (eScooter: safety opportunity)	STEP 3 • Additional/Advance Use Cases not defined yet[3]
CAR-TO-PD		**DA / DW[1] / NSC-VA[1] / SC-VA[1]** STEP 1 • CPNAO (#4 SCP-RD) • CPFAO (#5 SCP-LD)	STEP 2 • Additional/Advance Use Cases not defined yet[3]
SAFE DRIVING	**Local Hazards[2]** Dossier and on-track testing (if feasible) to evaluate the capability of a vehicle to trigger, send, receive and display local hazards. **Red-light violation of the ego** (outlook - infrastructure dependant)	**Red-light violation of the opponent**	
POST-CRASH SAFETY	**V2X Post-crash warning** Passive safety testing to evaluate the capability of the vehicle to warn the surroundings road users when this one has an accident.		
CRASH PROTECTION (Safety opportunity)		**V2X pre-crash exchange with potential collision opponent**	

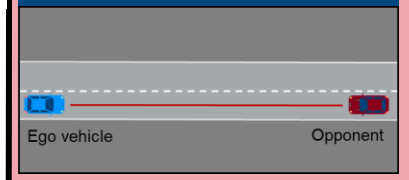
SECUR

SECUR Use cases
by Euro NCAP rating schemes

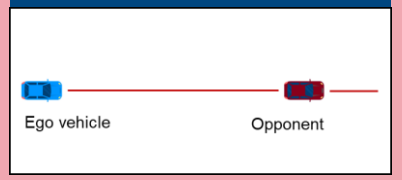
Confidential do not disseminate without SECUR's approval.

Crash Avoidance

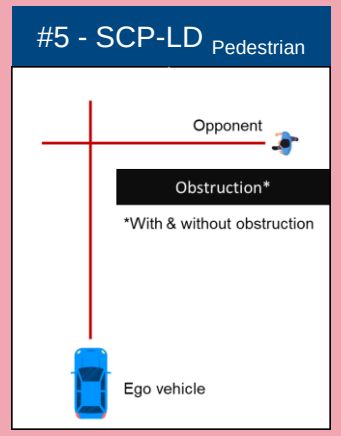
#01 – Head-On Pas. Car



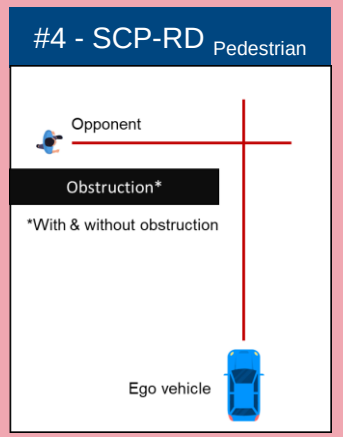
#10 - RE-FV Pas. Car



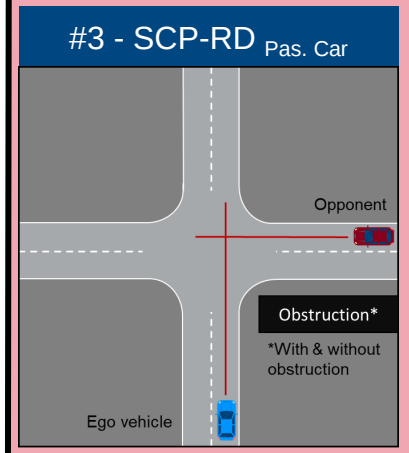
#5 - SCP-LD Pedestrian



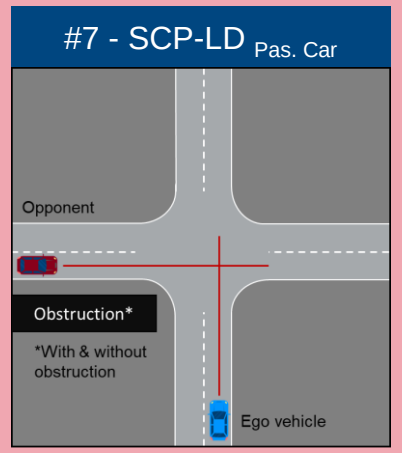
#4 - SCP-RD Pedestrian



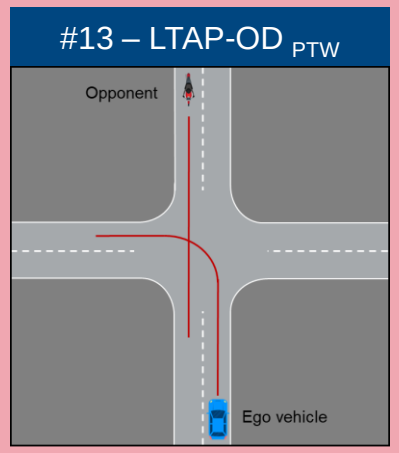
#3 - SCP-RD Pas. Car



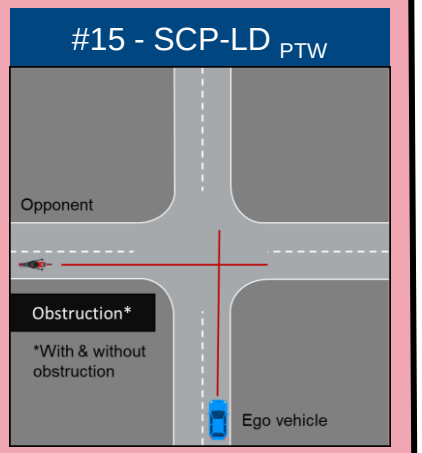
#7 - SCP-LD Pas. Car



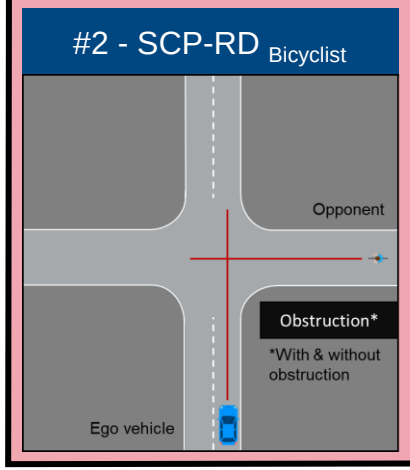
#13 – LTAP-OD PTW



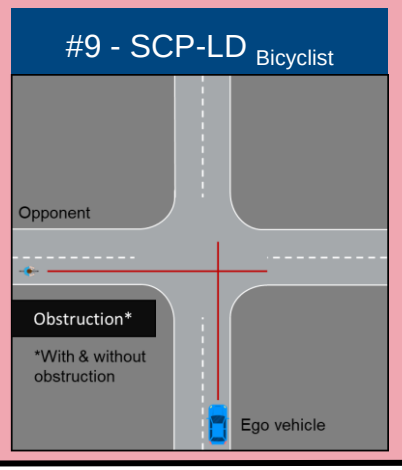
#15 - SCP-LD PTW



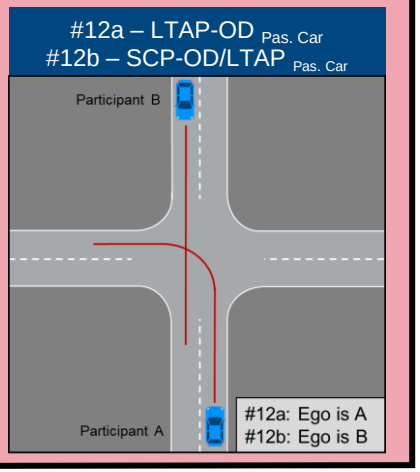
#2 - SCP-RD Bicyclist



#9 - SCP-LD Bicyclist

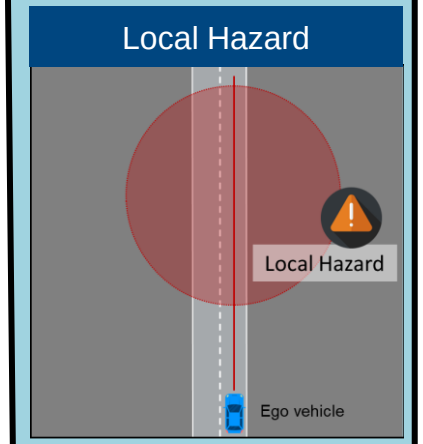


#12a – LTAP-OD Pas. Car
#12b – SCP-OD/LTAP Pas. Car

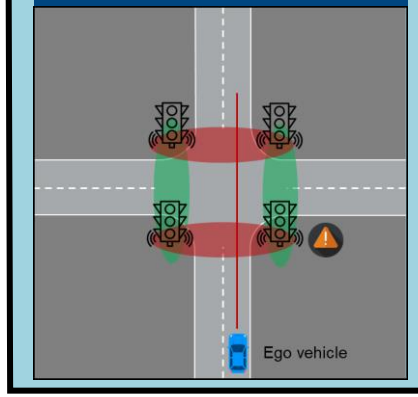


Safe Driving

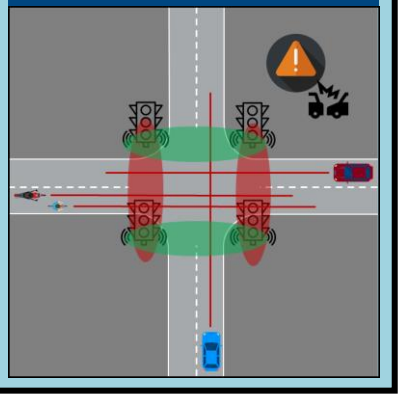
Local Hazard



Red-light violation ego

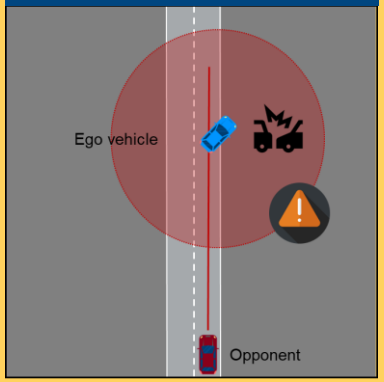


Red-light violation opponent



Post-crash Safety

V2X Post-Crash Safety



Crash Protection
Safety opportunity

V2X Crash Protection

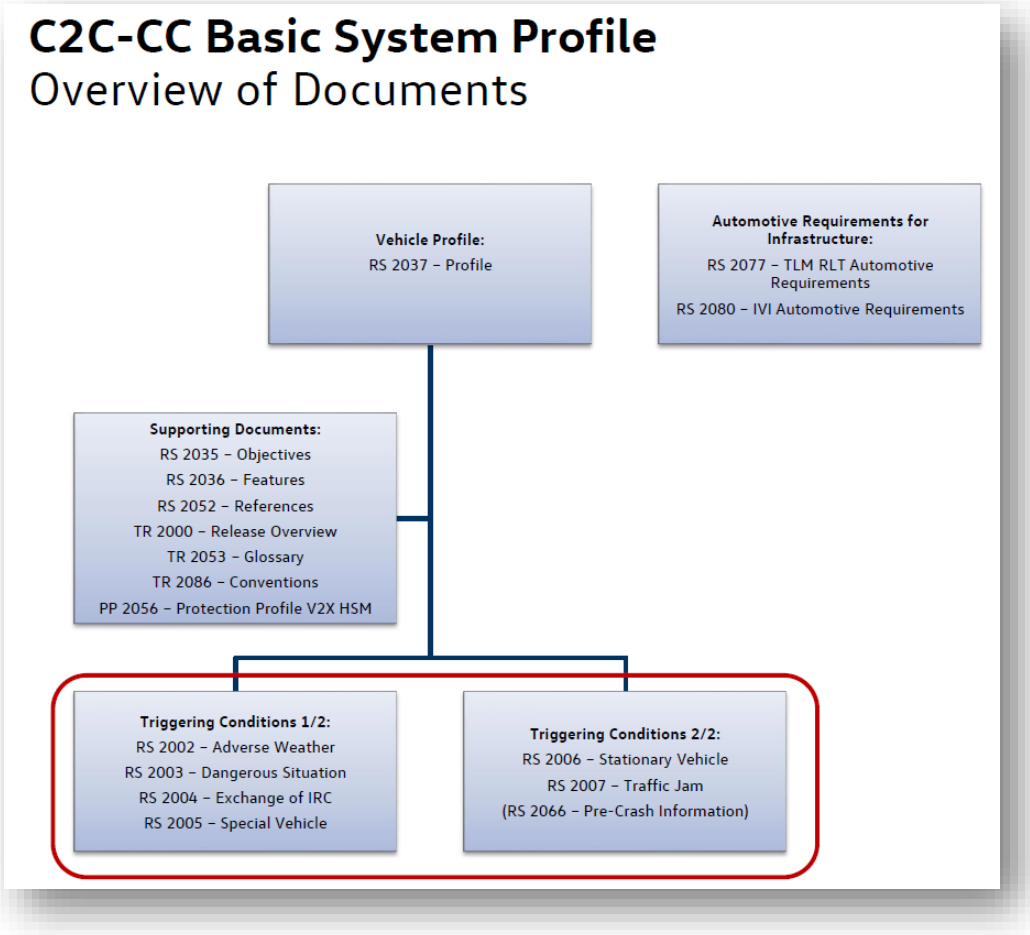
Crash Protection:
Fusion of V2X with Pre-Crash systems to improve the knowledge of the situation and the effectiveness.

Other inputs

C2C-CC DOCUMENTS
LOCAL HAZARDS DEFINITION AND TRIGGERING CONDITIONS

SECUR
Safety Enhancement through Connected Users on the Road

- Adverse Weather Condition
  - Traction loss (i.e., slippery road)
  - Fog
  - Precipitation
- Dangerous Situation
  - Electronic Emergency Brake light
  - Automatic brake intervention
  - Reversible occupant restraint system intervention
- Special Vehicle
  - Emergency vehicle in operation
  - Stationary safeguarding emergency vehicle
  - Stationary recovery service warning
- Stationary Vehicle
  - Stopped vehicle
  - Broken-down vehicle
  - Post-crash → to use in the post-crash safety rating scheme
- Traffic Jam
  - Dangerous End of Queue
  - Traffic jam ahead
- Exchange of Impact Reduction Containers (IRC)
  → to use in the crash protection rating scheme (SECUR see this as a safety benefits but was not studied in SECUR.



V2X TESTING NEEDS AND CAPABILITY BY V2X TYPES

SECUR
Safety Enhancement through Connected Users on the Road

V2V

Passenger car connected target for the test:
- On-board connected target (preferable solution) | ✓ Available
  Off-board connected target | ✓ Available
  - ➢ Real non connected target on-track and use of a remote V2X system (direct communication) to send the V2X messages with the target live dynamic data)
- V2X simulation | ✓ Available
  - ➢ Digital twin solution with simulated dynamic and scenario data

Testing V2X acquisition – V2X messages log:
- Road-Side Unit (RSU) near to the test track | ✓ Available
- Log with the on-track connected module use for the test | ✓ Available
- V2X test data logging software | ✓ Available

V2I

If only V2X consider infrastructure during the test:
- Use of a V2X system to simulate a connected infrastructure with realistic parameters (e.g. internal treatment timing) (preferable solution) | ✓ Available
  - ➢ Simulation of the infrastructure possible without the need of real on-track infrastructure
- Use of real infrastructure for the test | ◌ Connected infrastructure available but not tested in Euro NCAP scenarios.

If other systems (e.g. camera) consider infrastructure during the test:
- Use of real infrastructure for the test | ◌ Connected infrastructure available but not tested in Euro NCAP scenarios.

V2VRU

VRU connected target for the test:
- On-board connected target (preferable solution) | ✗ Not available
- Off-board connected target: | ✓ Available
  - ➢ Real non connected target on track and use of a remote V2X system (direct communication) to send the V2X messages with the target live dynamic data
- V2X simulation | ✓ Available
  - ➢ Digital twin solution with simulated dynamic and scenario data

Testing V2X acquisition – V2X messages log:
- Road-Side Unit (RSU) near to the test track | ✓ Available
- Log with the on-track connected module use for the test | ✓ Available
- V2X test data logging software | ✓ Available

V2N

Testing environment should be homogeneous between labs and representative of the current average network | ✗ Network requirements still to be defined for testing

Road user network connected target for the test:
- On-board connected target (preferable solution) | ✓ Available
- Off-board connected target | ✓ Available
  - ➢ Real non connected target on track and use of a remote V2X system (indirect communication by the network) to send the V2X messages with the target live dynamic data
- V2X simulation | ✓ Available
  - ➢ Digital twin solution with simulated dynamic and scenario data

Testing V2X messages acquisition: V2X messages log with the connected target or the remote V2X system

CRASH AVOIDANCE
Overall assessment methodology

SECUR
Safety Enhancement through Connected Users on the Road

SCENARIO TYPES

Scenarios possible with on-board sensors only

ASSESSMENT METHODS

Main assessment method

OEM's choice by test case (e.g. speed combination)

OEM Choice 1:
Non-connected test, i.e., with a non-connected target (V2X function switched off).
*Pass = full points (**100%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 2:
Connected test, i.e., with a connected target (V2X function switched on)
Pass = part of the points, less than choice 1
(100% -X_A%)

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 3:
Availability and performance of driver awareness (V2X function switched on)
Pass = part of the points, less than choice 2
(100% -X_B%)

Driver Awareness*:
In relevant situations, a clear and effective HMI should communicate the right information to the driver (e.g. direction and type of risk). Additional Points (few) if the VUT is fitted with driver awareness.

SCENARIO TYPES

Scenarios NOT possible/difficult with on-board sensors only (Implicit need of V2X by design)

ASSESSMENT METHODS

Secondary assessment method

OEM's choice by test case (e.g. speed combination)

OEM Choice 1:
Connected test, i.e., with a connected target (V2X function switched on)
*Pass = full points (**100%**)*

Pass/mitigate a test case with vehicle action reward with more points than FCW.

OEM Choice 2:
Availability and performance of driver awareness (V2X function switched on)
Pass = part of the points, less than choice 1
(100% -X_C%)

Driver Awareness*:
In relevant situations, a clear and effective HMI should communicate the right information to the driver (e.g. direction and type of risk). Additional Points (few) if the VUT is fitted with driver awareness.